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A COLLECTION

OF

MEMOIRS

ON THE VARIOUS MODES

ACCORDING TO WHICH

THE NATIONS OF THE

SOUTHERN PARTS OF INDIA

DIVIDE TIME:

TO WHICH ARE ADDED,

Three General Tables, wherein may be found by mere inspection the
beginning, character, and roots of the Tamul, Telinga, and
Mahommedan Civil Years, concurring, viz. the two former
with the European Years of the XVIIth, XVIIIth and
XIXth Centuries and the latter with those from
A. D. 622 (A. H. 1) to 1900.

By

LIEUTENANT COLONEL JOHN WARREN.

Thos. Foulkes

- - - - - - - - - Si fortè lepos austera canentes
Deficit, eloquio victi, re vincimus ipsâ.

MADRAS:

PRINTED AT THE COLLEGE PRESS.—1825.

TO THE

BOARD OF SUPERINTENDENCE

OF THE

COLLEGE OF FORT ST. GEORGE,

UNDER WHOSE AUSPICES AND PATRONAGE

IT WAS UNDERTAKEN AND COMPLETED,

This Work,

IS RESPECTFULLY INSCRIBED

BY

The Author.

MADRAS, *26th February* 1825.

PREFACE.

The present work, which has assumed a variety of shapes since it was first undertaken, was originally intended for the sole use of the Honorable Company's College of Fort. St. George. It was subsequently conceived that some of its Tables might be of service to Gentlemen employed in the Revenue and Judicial departments, and on that account the original manuscript (as far as it then extended) was purchased by Government in the year 1815: since that time it was considerably augmented, with a view to render it more deserving of the patronage it had received.

The irregular progress of the composition of these Memoirs, has unavoidably occasioned a defect in the arrangement of their parts, which the Author found subsequently impossible to remove entirely, and on that account he claims the reader's indulgence. The various employments which he held in His Majesty's Civil and Military services in different parts of the world, during eleven years that this work was in hand (though he admits, an insufficient excuse) may perhaps abate the rigour of criticism on what refers to style and method; and more than any other consideration, the circumstance of its having been originally undertaken at the call of private friendship and continued, after the object of it had ceased to exist, with the sole view of being serviceable to a public institution, without any prospective advantage to himself, will, the Author hopes, save him from the reproach of having rashly intruded his imperfect labours on the attention of the public.

The results of the present research can be of no sort of use to European Astronomy: they were derived from systems which we see no where supported by recorded observations, or modified (for several centuries past) by improved theories. The Author begs it further to be understood, that these Memoirs are not designed to support or combate any doctrine or conjecture, on the past and present state of Hindu Astronomy; their chief object being merely to explain the various modes according to which the Natives of India divide *time*, in these southern provinces, and to render their Kalendars intelligible. These may, therefore, be properly considered rather as instruments contrived for Chronological purposes, than as Astronomical Tracts.

Each Memoir contains several Tables intended to abridge the tedious process of converting dates proposed according to European style, into the corresponding Tamul, Tellinga, and Mohommedan time, and vice versa.

The expediency of such an attempt was originally suggested by the late Mr. F. W. Ellis, Senior Member of the Board of Superintendence of the College of Fort St. George, who conceived that a work which would facilitate the comparison of the European and Hindu Chronologies, would be attended with the double advantage of relieving the Officers of Government from much uncertainty in the administration of public affairs, and at the same time of affording to the learned Natives of this part of India (some of whom are tolerably proficient in the English language) the means of acquiring the knowledge of our own methods of fixing epochs and recording events.

This conception was worthy of a Gentleman so well known to the Indian public for his powers of research, and enlarged views of administration; but he was not aware of the difficulties which surrounded its execution. At the time when he first proposed it to the Author, the knowledge of Hindu Astronomy was almost entirely extinct among the Natives of the Carnatic, and with very few exceptions, totally neglected by the Europeans. Some straggling Astrologers attached to the service of opulent Natives, and some obscure Almanac makers might, it is true, occasionally furnish a table, and a formulæ, such as were collected by La Loubére, Father Duchamp, Father Beschi, Le Gentil and others; but none were to be found capable of leading the Author into the obscure paths of Hindu Chronology or Astronomy; a case very different from that of our learned cotemporaries in Bengal, who, whilst we were gleaning in a withered field for a few decayed materials, gathered ample stores from the collections of learned Natives and Brahminical institutions, not unassisted by well informed *Pundits*, *Mulavies* and *Jyantish Sastras*.

The labour of collecting and verifying the materials on which these Memoirs are founded was, therefore, much more considerable than was anticipated, and time and perseverance alone have enabled the Author to erect his work on authentic information.

The present production, if it fails in other respects, will at least serve to show nearly the present extent of our knowledge in Hindu Astronomy in these southern provinces, and in the absence of every other merit, the Author may perhaps be suffered to claim some credit for having been the first in the Carnatic, since the days of Beschi and Le Gentil who, unassisted, has endeavoured to draw the public attention on a subject of this nature.

Independently of his wishes to gratify the curiosity of Europeans, the Author had also in view (perhaps in a greater degree) to familiarize the learned Natives with the use of Tables constructed and disposed in the manner of those of the European Mathematicians; and also to reconcile them to the idea of brevity and expedition in computations, to which they are singularly averse, from a supposition that nothing can replace the entire exposition in figures of every part of the problems they are to resolve. In this attempt he found himself more successful than he had a right to expect—his Tables for the *Ahargana* of the Sun, Moon and Jupiter, intended to reduce the endless multiplications and divisions of the Sastra rules to addition and subtraction, and to elicit, by a short process, the number of days, and fractions of days expired from a given epoch to the time for which the computation is made, after due examination by the best informed *Jyantish Sastras* in Madras, have been pronounced "equivalent to the respective rules which they were intended to abridge," and they have manifested an intention of using them in future.

To the skill required for constructing the Tables referred to, the Author does not attach the least importance; these wanted neither depth of science nor ingenuity of contrivance; but what has gratified him was, to find a prejudice shaken which stood in the way of improvement, and a wish on the part of the better classes of the Natives (long since manifested in Bengal) to become better acquainted, than they were hitherto satisfied to be, with European doctrines and knowledge.

In order to avoid the risk of entering into scientific controversy, the Author has carefully avoided all dissertations which might lead him out of the confined scope which he has prescribed to himself. Whether modern (or sydereal) Astronomy was instituted so near to our times as the year of Christ 538, as some pretend, or whether its origin lies concealed in the obscurity of time, he shall not consider; but will expound the operation of the system now universally in use in India, as if it had ruled all past ages, and were to continue to do so to the end of time.

This assumption, although manifestly imaginary will, however, suffice for immediate purposes; for what public record can there fall under the cognizance of the Magistrate or of the Collector, that should bear an older date than the year of Christ 538?—and where is the probability that the ancient Tropical system (which is said to have been superseded at that epoch) will ever return into use among the Natives?

For the same reason, the Author will abstain from canvassing the opinions of learned cotemporaries on certain astronomical notions, which are affirmed and denied with equal confidence.

Whether, for instance, the supposed libration of the equinoctial points about the beginning of the fixed Hindu Zodiac (absurd as that notion no doubt is) proceeds from the error of European Scholiasts on certain passages of the Surriah, Vasist'ha, and Varasanita Siddhanta; or whether that doctrine be actually expressed with various modifications in the respective texts, is what he shall not pretend to determine: but, as Mr. Davis found that notion established among the Jyautish Sastras at Benares, in the year 1786; Mr. Andrew. Scott in the Northern Circars, in 1790, and the Author in the Carnatic, in 1814, without any difference of opinion among the Native Mathematicians, he thought himself justified in a *practical work*, when speaking of the Indian *precessional variation*, to use their own language; a compliance which is subject to no inconveniency, because even if it be supposed that the precession ceased to be retrograde in the year before Christ 6701, (as some will have it), the same theory does not admit that it can resume the same course before A. D. 7699, an Epoch so remote from the times in which we live, that it is a matter of perfect indifference to his present object, which of the contending parties has best understood the text; the more so, that the motion of the Equinoxes is supposed variable in neither doctrines, and that even those who support the system of libration admit neither decrement, nor increment, as it approaches to or recedes from its limits.

As this work rests on three distinct doctrines, viz. 1° What relates to the Tamul Solar year on the authority of the Aria Siddhanta. 2° What refers to the Luni-solar Astronomical year and Kalendar of the Tellingas, on that of the Surriah Siddhanta. 3° and lastly, what concerns the Mahommedan Kâlendar on the Arabic system,—it was found indispensable to divide it into several parts.

The whole collectively taken, was denominated by some learned friends *Kala Sankalita*, a Sungscrete word signifying the doctrine of times. It presents (as far as the Author knows) the first attempt that was made in India to investigate and explain the elements of Hindu Astronomical Chronology, and to disclose to Europeans the contents and structure of those humble annual Kalendars which, written on palmyra leaves have, during nearly two centuries, been sold under their eyes without their even suspecting the skill and labour which their computation required.

The first Memoir, called a Key to the *Madhyama Saura Mana*, contains an exposition of the mean Solar Sydereal year used by the Tamul inhabitants of the Peninsula of India. It shews 1° How its beginning, that of each of its months, and the rank of every day in the year and month, are to be determined, according to Sydereal (by some called improperly Astronomical) or Civil account. 2º How any date proposed in either of the old or new European styles may be converted into its corresponding Tamul date or *theidy*, and vice versa. There will be found at the end of the Volume certain Tables for resolving most cases referring to Solar time, without having recourse to the endless process of Native Astronomers.

Some parts of these theories, and of the three first Tables, were extracted from Father Beschi's tract on the Tamul time, which forms the 3º Appendix to his Dictionary.

The Key to the *Madhyama Saura Mana* forms an indispensable introduction to the second Memoir, as it is impossible to compute the end of any Luni-solar year, month and day, without a previous knowledge of the concurring Solar divisions of time, and as both are usually registered together in the *Chandra Panchangum*, or Luni-solar Kalendar. The Tables annexed to the first Memoir for the commutation of dates, will also serve for the second, with this only reservation, that if the date proposed be expressed solely in terms of Lunar tidhis, which depend on the Sun and Moon's relative motion (a case of very rare occurrence), then the Solar concurring day must be expounded by means not conveyed in the said Tables.

Two General Tables are given at the end of the Volume, the first of which refers principally to the Memoir on the Solar year. Besides other articles, it exhibits the beginning of each Tamul year reckoned from the beginning of the Cali yug, and the birth of Salivahana, concurring with the Christian years of the XVIIth, XVIIIth and XIXth centuries, according to the Julian and Gregorian styles, as far down as A. D. 1752, and to the latter only down to 1900. The Dominical Letters according to the two styles follow, and the initial feriæ and monthly dates, of beginning, as well as the roots of each year, are given in the two last columns, according to Hindu Sydereal and Civil accounts.

This Table gives also the names and ranks of the years of Jupiter's Cycle of 60 years, agreeably to the *three* accounts of the Surriah Siddhanta, the Jyantistava, and that of the Tellingas, who make Jupiter's and the Solar year, equal: The two first accounts being followed in Bengal and the last in the Peninsula.

The numerals of the years of the Cycle of 90 years, used in the Tanjore, Travancore, Madura and Tinnivelly provinces, are inserted in the 6th column.

In the second General Table will be found, the Christian years of the XVIIth, XVIIIth and XIXth centuries, with the concurring Luni-solar years of the Caliyug, their character, i.e. whether the year be a common or an intercalary one, the feriæ and monthly dates of the last conjunction of the year, when the ensuing year begins. The date of the same according to the Tamul Kalendars, and the Solar and Luni-solar *Ahargana* from which is deduced the juxta position of the beginning of the respective Solar and Luni-solar years. This Table, therefore, furnishes by mere inspection, the commencement of the Luni-solar year of the three centuries most wanted in present times, showing the day of the week, the monthly (Gregorian) date, and the Tamul Solar date of the same; and furthermore supplies the two elements first wanted for computing the beginning of every Solar and Luni-solar month and tidhi in any of the said proposed years.

The second Memoir, entitled a Key to the *Siddhanta Chandra Mana* (as it is called in the Peninsula), contains the theory and construction of the Luni-solar Astronomical year, on which hangs the whole fabric of Hindu Astronomy.

In analyzing and unfolding the construction of a Kalendar which seems to have been invented for the purpose of perplexing the Astronomer and confounding the Chronologist, the Author confesses that he had often to guess before he could demonstrate, and that he has been long groping in a dark and pathless heath before he could see clear before him, and decipher the columns of the common Patra, or Panchangum, which is sold and read in every village of India; for although the system on which it rests rules all the astronomical computations of the Hindoos,—governs their religious festivals and sacrifices,—the expiatory ceremonies for the dead,—the agricultural dispositions which depend on the contingencies of the seasons,—and lastly, the endless train of superstitious observances, the epochs of which are determined by the science of Astrology (alike cherished by the Hindu and the Mussulman), yet the leading features of the Luni-solar Kalendar, are to this day much less understood by the Europeans who reside in this part of India, than any other measure of time used in any part of the world.

If it be considered that the doctrines on which these humble Kalendars are calculated, have from time immemorial ruled the Chronology of many civilized and wealthy nations, the subject of the second Memoir may not be deemed undeserving of the attention of the votaries of science. Its subdivisions treat of the following matter, and have in view, 1º To explain the principle and construction of the Luni-solar Kalendar, as it would be calculated for Lanca (if such a place were in existence), under the first Meridian and the Equator, and then to reduce the same to some other geographical position.

In the first division of the second Memoir, the computation of the different elements is explained according to the rules of the Surriah Siddhanta: a whole section is devoted to Hindu Gnomonics, the problems of which are indispensable for finding the true time of the circumstances of the year at any place which has longitude and latitude. The Trigonometrical demonstrations of the problems by which the Right Ascension, Declination, Longitude, Zenith Distance and Amplitude of the Asters are determined, will be found with Table XXX, page 36, 37 & 38 of the Tables, at the end of the Memoirs.

2º To determine the periods of mean intercalations from which the true intercalary or expunged months due to certain Luni-solar years may be deduced.

3º The method of computing the various collateral articles of the Luni-solar Kalendar, according to the Rules and Tables of Vavilala Cuchinna, an Indian Astronomer whose works are much esteemed and used in Tellingana.

This latter Section is exclusively the work of the late Mr. Andrew Scott, a Gentleman no less to be regretted for his amiable qualities, the uprightness of his mind, and the simplicity of his manners, than for his extensive information in every branch of knowledge, and the liberality with which he imparted it to those who were qualified to benefit by his instructions. Some parts of this commentary might perhaps have been enlarged with a view to render it more accessible to persons not versed in Hindu Astronomy: but the author would have thought himself guilty of presumption had he pretended to improve any production that came from one whom he knew to be so eminently versed in the science.

The Tables which accompany the second Memoir, were procured from various sources. Those of Maracanda were borrowed from Mr. Davis' Memoir on the Astronomical computations of the Hindus. The Solar and Lunar Tables, also those of the Planets, are due to Mr. Scott's kindness. The Tables used for computing the Luni-solar Kalendar according to the precepts of Solar Astronomy (otherwise called the Vakiam process in the Peninsula) were furnished by Ruttani Audi Sashya Sastri, a Brahmin employed as Native Astronomer in the College of Fort St. George, to whom the Author owes a great part of the information he possesses on the construction of the Luni-solar Kalendar.

These three Tables are, he supposes, the same as were given to the public many years ago, by Father Duchamp, though he is not perfectly certain of the fact. They are now very scarce in this part of India, for it was with difficulty that those referred to were procured. The rest of the Tables were either obtained from native Indians, or constructed by the Author as occasion required.

The third Memoir refers to the Indian Cycle of 60 years, called by the Hindus, the Vrihaspati Chaera. It expounds the three different ways according to which it is computed ; viz. the first according to the Surriah Siddhanta, (used north of the River *Nermada*)—the second on the precepts of the Jyautistava, a book on Astrology, used in some of the Northern Provinces of Bengal, but little known in Southern India—and the third being the Cycles used by the Tellingas, which merely consists of 60 solar years.

In the three above mentioned Memoirs the Author takes as *data* all that has appeared in Mr. Davis' two Tracts on the Astronomical computations of the Hindus in the second and third volumes of the Asiatic Researches. On the contrary, what appears new to him (though perhaps not so to certain scientific readers) he will endeavour to explain to the best of his abilities.

The fourth Memoir expounds the construction of the Mahommedan Lunar year, and furnishes a General Table (inserted after the Solar and Luni-solar Chronological Tables) shewing the commencement of every year of the Hejira, from the origin of the æra to the Lunar year corresponding with A. D 1900; according to the Julian Kalendar, as low down as the year 1582; and from thence according to both, down to the end of the Table.

The Appendix contains several Tracts, the first of which exhibits Tables for computing the Solar and Luni-solar Aharganas from an assumed epoch to any proposed instant of time, without having recourse to the rules of the Sastras. The second contains a particular method for expounding dates found on old inscriptions, the only vestiges of which may be either the *name* (or numeral) of the year according to some of the Hindu Styles, or the Sun's apparent place in the Hindu Sydereal Zodiac, at the time of the commemorated event. The third gives a short Chronological Tract, written for the purpose of facilitating the reduction of any date proposed according to Hindu Solar time, to the dates of the principal ancient and modern æras: and the fourth a specimen of the Hindu Kalendars and Ephemerides. Next follow four Fragments containing matter which may interest all sorts of Astronomers; after which the work concludes with a Glossary of the Sanscrit Astronomical terms contained in the text, of which it is also an Index.

The Author owes, perhaps, some apology for having extended in several instances, his speculations to very remote periods, both in past and future ages; the necessity, or even utility of which, are at first sight not very apparent. But those who are at all acquainted with any system of Astronomy, and particularly with that of the Hindus, need only be reminded that it would have been impossible to attempt any construction or analysis depending thereon, without subjecting both to the test of time, in the revolution of ages, and what might appear to the uninformed a mere affectation of research and accuracy, will be judged by the former to arise out of the peculiar structure of a system of Astronomy, the correctness of which rests on the immense scope of its cycles and the vast intervals of its epochs.

This last consideration will indicate the quantum of labour which the present research has occasioned; for if it be considered that altho' most Hindu formulæ are very simple, even for the solution of the higher problems, yet the immense dimensions of certain quantities, expressed in natural numbers, and amounting in some cases to thirteen places of figures, renders for handling them, the use of Logarithms totally unavailable, and the European as well as the Hindu computers are compelled, in most cases, to remain satisfied with that perpetual and unwieldy instrument of Hindu Astronomy, the *Trírasica* (or rule of three) for expounding the minutest as well as the most comprehensive quantities.

It has been objected by some Gentlemen who have read these Memoirs in manuscript, that the Author has entered more deeply into the theories of Hindu Astronomy than was necessary in a work which referred principally to Chronology; but to this observation he may be permitted to answer, that for any Kalendar like those now used in Europe, where it was agreed to give to the months an arbitrary, but permanent duration, and to equate the years by certain periodical intercalations, the recurrence of which was clearly determined, there was no difficulty in devising a perpetual Kalendar for enabling any person tolerably well informed, to convert any date proposed in one style into another, without the assistance of theory.

But the case is quite different when referred to any sort of Hindu Kalendar, where there are hardly any instances of an arbitrary distribution of time, for excepting some occasional *Cshepas* (a constant number added or subtracted in certain computations to make the time fit a particular epoch) and some complementary fractions of days added to the beginning of certain Solar years, in order to complete the time due to a given number of mean Solar revolutions, the course of the Asters remains as uninterrupted in the Kalendar as it is in their orbit.

As the singular form of the Indian *Patras* (or Kalendars) may be a matter of curiosity to Europeans, the Author has translated and inserted at the end of the volume, the first page of the *Ravi* and *Chandra Panchangam* (Solar and Luni-solar Kalendars) for the year of the Caliyug 4925, coinciding with A. D. 1824, and containing the first month of the respective years, with their usual astrological appendage, both being unlike those of any other nation, ancient or modern.

The Solar Kalendar is computed in Solar, and the Luni-solar in Sydereal time, and with different elements, which accounts for the difference of epochs assigned in each to the same phœnomenæ (amounting sometimes to 8 hours and 58 minutes in *plus* or *minus* of European time), a circumstance which so operates, that the New Moon which is predicted in the one for a particular day, is, on the same spot, and computed perhaps by the same Astronomer, often registered for the next, in the other; a remark not to be neglected by Chronologists when they attempt to fix an epoch with precision by means of old Hindu Kalendars.

The Author readily admits that there must be many faults in the present production, some of which may perhaps not be deemed altogether excusable by those who are versed in Hindu Astronomy. Of the little merit it may possess it is not for him to speak, but he may aver, without offending truth or modesty, that he has neglected no pains to render it deserving of the patronage it has received, trusting that all liberal and candid readers will remember that in such matters,

" Optimus ille est qui minimis urgetur."

Before closing this introduction, the Author, in justice to the memory of the late Mr. Ellis, feels bound to record in this place, his acknowledgments of the personal assistance which he received from that Gentleman during the beginning of the present research, and the patronage of the Board, of which he was the senior Member, which brought originally the work to the notice of Government. He stands under a similar obligation to Mr. Oliver and Mr. Richard Clarke, Mr. Ellis' successors in the superintendence of the College of Fort St. George.

His thanks are also due to Mr. Hyne of the H. C.'s Medical Service, (a Gentleman well qualified for the task) for his trouble in perusing and commenting the original manuscript, before it was ordered to be printed: and to R. Audy Shashya Brahmini, the Native Astronomer attached to the College, for his professional assistance during nearly two years that he communicated with him on the subject of these Memoirs.

Lastly, the Author embraces this opportunity for paying a last tribute of respect and gratitude to the memory of the late Mr. Andrew Scott, of the H. C.'s Civil Service, for many valuable and important communications in a science which in past times, he cultivated with success, and without whose assistance several of the papers contained in this collection could never have been completed.

MADRAS, 1st *March*, 1825.

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Those who only look in this Book for that sort of information which requires no labour, and is to be obtained by mere inspection, are referred to the Indian Chronological Tables inserted at the end of the Volume.

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FIRST MEMOIR.

A KEY TO THE MADHYAMA SAURA MANA

OR

MEAN SOLAR SYDEREAL YEAR,

USED BY THE

TAMUL INHABITANTS OF THE PENINSULA OF INDIA.

Written in the year 1814*; Revised and augmented in* 1824.

A

KEY TO THE MADHYAMA SAURA MANA.

PART I.

General account of the Solar Sydereal and Civil years, as used by the Tamul inhabitants of the Peninsula of India.

In most of the tracts that have hitherto been published on Hindu Astronomy, or Chronology, it has been assumed that the reader was sufficiently well acquainted with the elements of these sciences not to require a second initiation ; a very mistaken idea, whether it be propagated in Europe or in India, and which, for obvious reasons, I shall not adopt on entering into the subject of this Memoir. How to open the elementary part of it without alarming the reader by a long series of definitions expressed in a dead oriental language, or how to reduce the preliminary notions which these definitions are meant to convey, to a convenient scope, without risking to become unintelligible, is an alternative which leaves only a choice of difficulties. On mature consideration, however, I have thought it adviseable to follow a middle course, and shall consequently present definitions to his attention only as they become necessary in the progress of these Memoirs, unless they be of a nature very general, and easily understood. What my expositions may lose by such an option from want of scientific arrangement will, I hope, be balanced by the advantage of this research being introduced under a less discouraging aspect.

This first Memoir contains very little theory. The construction of the Solar year, such as it is generally used in that part of India which lies South of the river *Nărmădă* (believed to be the same as the Nerbudda), is extremely simple when compared to that of the Luni-solar year. The perusal of it, therefore, requires little or no mathematical knowledge ; but it forms, nevertheless, an indispensable introduction to the latter ; and in order to render this part as efficient for that purpose as possible, a great portion of the following pages will be occupied by the exposition of certain mechanical rules, whereby the various circumstances of the common Hindu Solar year, may be easily discovered. The time consumed in becoming acquainted with these, will be recovered with profit, when in the second Memoir, we come to treat of the Astronomical year of the Hindus, the whole construction of which rests on principles so different from those of European Astronomy, that all elementary notions of that science must be laid aside for a time by the reader, if he be desirous to avoid the inconveniences which must necessarily result from premature conclusions.

SECTION I.

Of the division of Time into years, seasons, months, days, and fractions of the same; principally according to the Tamul Kalendar.

ARTICLE I.

The Tamul Solar year (as it is improperly called in the Carnatic) is Sydereal, it contains that space of time during which the Sun departing from a Star, returns to the same.

Beginning of the Solar year referred to the beginning of the Lunar Zodiac by the ancients, and to that of the Solar Zodiac by the moderns.

Ancient Astronomers (by which distinction I mean those who rejected all computations made in Solar time) accounted it to begin when the Sun enters the Lunar mansion *Aswini*, the first of the twenty-seven regular *Nacshatras* contained in the fixed Lunar Zodiac (*). But modern Astronomers, who regulate the year by the Sun's revolutions without any reference to those of the Moon, account the year to begin, when that luminary enters the Sign Mesha (the Indian Aries) of the fixed Solar Hindu Ecliptic.

Civil and Sydereal account.

Each Solar month contains as many days and parts of days as the Sun stays in each Sign. The *Civil* differs from the *Astronomical* account only from its rejecting fractions of days, each year and month being accounted to begin at Sun-rise, instead of the time of his mean entrance into the respective Signs; observing that if the said fraction exceeds 30 Indian hours (24 European minutes to a *danda* or *guddia* being the term for an Indian hour) which lapse of time is conceived to be the *mean* half of the day, then the Civil year, or month, are accounted to begin one day later than the Astronomical ones; whereas if the time falls below that quantity, both coincide.

The seasons.

The Hindus divide the Solar year into six seasons (called *Ritu* in Sanscrit) of two months each, the succession of which is always the same, but whose vicissitudes as to climate, depend on the place of the Sun's Apogee in the fixed Zodiac, and the position of the Equinoctial Colures relatively to the beginning of the Sydereal Zodiac. Their order and names, under all possible circumstances, as well as that of the months which they comprehend, are according to the Hindu and Tamul denomination as follows. (†)

HINDU.

1 Vasanta.	2 Grishma.	3 Varsha.	4 Sarada.	5 Hemanta.	6 Sisira.
Chaitra ♓	Jyaishta ♉	Sravana ♋	Aswina ♍	Margasirus ♏	Magha ♐
Vaisacha ♈	Ashar ♊	Bhadra ♌	Cartiga ♎	Paushia ♑	Phalguna ♒

TAMUL.

Poongoni ♓	Vyassei ♉	Audi ♋	Paratasi ♍	Cartiga ♏	Tye ♐
Chaitram ♈	Auni ♊	Auvani ♌	Arpesi ♎	Margali ♑	Maussi ♒

(*) The Solar and Lunar moveable Zodiacs are called Tropical; and their position, relatively to the Sydereal ones, depends on the precessional variation: called *Cranti Pata-gati* in Sanscrit.

(†) It will seem extraordinary that the Tamul Astronomers should have adopted a different distribution of the months of their Solar year when referred to the seasons, from that of the other Hindus. Such, however, is the case, for according to them, the months and seasons are arranged as follows:

1 Vasanta.	2 Grishma.	3 Varsha.	4 Sarada.	5 Hemanta.	6 Sisira.
Chaitram ♈	Auni ♊	Auvani ♌	Arpesi ♎	Margali ♑	Maussi ♒
Vyassei ♉	Audi ♋	Paratasi ♍	Cartiga ♏	Tye ♐	Poongoni ♓

which advances the Tamul seasons by one month throughout the year.

The names of the twelve Signs of the Zodiac are

The signs of the Zodiac.

1	♈ Mesha,	2	♉ Vrisha,	3	♊ Midhuna,
4	♋ Carcata,	5	♌ Sinha,	6	♍ Canya,
7	♎ Tula,	8	♏ Vrischica,	9	♐ Dhanus,
10	♑ Macara,	11	♒ Cumbh'a,	12	♓ Min.

Names of the Ecliptic and Equator.

The twelve Signs together are called the *Rási Chacra*, or Circle of the Signs. The Ecliptic *Cranti Mandála*, and the Equator *Nári Mandala*. Their respective Poles *Druvas*.

Of months Surriah Siddhanta.

The names of the months used in the Surriah Siddhanta are the same as those of the Signs; adding *Masa* thereto. Those of the Tamuls are

Tamul months.

1	Chaitram,	2	Vyassei,	3	Auni,
4	Audi,	5	Auvani,	6	Paratasi,
7	Arpesi,	8	Cartiga,	9	Margali,
10	Tye,	11	Maussi,	12	Poongoni.

The names of the same months used more generally by the Hindus are

Bengal months.

1	Vaisácha,	2	Jyaishtá,	3	Ashar,
4	Srávana,	5	Bha'dra	6	A'swina,
7	Cartiga,	8	Margasiras or Agrahayan,	9	Paushia,
10	Mágha,	11	P'hal'guna,	12	Chitra.

The latter names are used by the Tellingas for their Luni-solar year, with this only difference, that as the common Luni-solar year, called *Chandra Mana*, is accounted to begin with the new Moon which precedes the commencement of the Solar year, the Lunar mouth *Chitra* begins, and *P'hal'guna* ends the year.

The space of time called day, variously considered.

The Hindus have a great variety of ways of considering the day, and of fixing its duration. The principal are,

1º The Savan, or natural day, is the time between two consecutive Sun risings, therefore the Savan days are of various duration, even under the Equator.

According to the ancient Sastras, or inspired books, the Savan day is divided into 60 dhatas or ghatica-dandas; the dhata 60 vinadicas; the vinadica 6 pranacalas; the pranacala 10 vipalas.

2º The Saura day is the time during which the Sun describes one degree of the Ecliptic. These days are therefore longer or shorter, as the Sun is near his Apogee or Perigee. They are divided in the same proportions as the Savan days, but with different names, viz. Danda, vicala or pala, pranacala, (or respiration) castacala.

Astronomers sometime divide time in minuter parts; thus the vipala, or castacala into 60 allipalas, the alipala into 3600 nimeshas or twinklings of the eye, on account of which this sort of time is denominated *Murta*, meaning as above.

Names of the subdivisions of the day according to the Tamuls.

3º The Nacshatra day, which is also frequently called Saura, with a different meaning from that formerly mentioned.—It is Sydereal, being the time between the *same point of the Ecliptic rising twice*; or rather the time between the Equinoctial points (called Ayana) rising twice. These days are accounted to be equal to one another throughout the year and are used by the Tamul Astronomers who compute in Solar time in their preparatory operations; being always equal to 60 guddias, subdivided sexagesimally into viguddias, paras and suras, which denominations are also used in Lunar computations. It is proper, however, to observe here, with a view to avoid future confusion, that the measure of time called guddia means also an arc or portion of a Nacshatra (or Lunar mansion) of 13° 20′, which is likewise subdivided into viguddias, paras, &c. having no immediate reference to time.

The fractions of the Solar day used in this Memoir are invariably the last mentioned. The Lunar day or Tidhi will be noticed more conveniently in its proper place.

Names of the days of the week.

The names of the days of the week are common to all styles and prevail all over India. They have the same signification as those used in ancient and modern Europe, and are as follows:

1	Sunday	Ravi-vara	Sun
2	Monday	Soma-vara	Moon
3	Tuesday	Mangala-vara	Mars
4	Wednesday	Bhuda-vara	Mercury
5	Thursday	Guru-vara	Jupiter
6	Friday	Sucra-vara	Venus
7	Saturday	Sani-vara	Saturn

Time of the Sun moving through the Northern and Southern signs.

The unequal portion of time assigned to each month, dependant on the situation of the Sun's Apsis, and the distance of the Vernal Equinox (called *Mesha Ayana*) from the beginning of the sign Mesha, is also affected by the difference of time which the Tamul Astronomers assign to the Sun for moving through the Northern and Southern signs of the Ecliptic, the time for the former being 186 days, $21^h\ 33^m\ 24^s$, and for the latter 178 days, $8^h\ 34^m\ 6^s$. The odd hours and minutes of which they apply to the beginning of the year and months; and being so distributed they do not require the assistance of Leap, or Bissextile years, because they reckon the Astronomical beginning of each, from the hour and minute over 365 days when the last year and month expired.

The Civil Solar year of 365 and 366 days.

The Civil year, however, is of 365 and 366 days, like that of the Europeans, the latter being determined by the rejection of fractions, as was already hinted at page 4, and not by any regular intercalation. It results from this arrangement that Civil time is sometime longer, sometime shorter than the Astronomical. Thus according to the Tamul computations the month of *Auni* of the year of the Cali yug 4817 (June 1745) commenced on Thursday at $44^{gud.}$ $50^{vig.}$ after mean Sun rise, which exceeding 30 guddias shews that it begun $14^{g.}$ $50^{vig.}$ after Sun set, and so by the Civil reckoning the first of *Auni* fell on Friday the 11th, instead of Thursday the 10th of June; and as it ended on Monday the 12th of July, it follows that the Sydereal month of Auni was of 32 days, and the Civil only 31. In the same manner, as the following month *Audi*, began on Monday the 12th July at 21^{g} 28^{v} 18^{p} (below 30 guddias) and ended on Thursday the 12th August at $49^{gud.}$ 40^{v} 20^{p} (above 30^{g}) it follows that the Civil month was of 32 days, and the Sydereal only 31.

From these preliminaries we shall be enabled to discover by means of the fraction of the root or initial feria of the month Chaitram and Solar year (called Soota dina) whether it be one of 365, or 366 days according to Civil account, but we must previously shew how the Tamuls compute the beginning of their years and months.

The four yugs.

In order not to crowd unnecessarily the matter on the reader's attention, I shall assume for the present that he knows that the Hindus have imagined, among several others, four grand periods which collectively taken form one of 4320000 years, called a *Maha yug* or great period of conjunction of the Planets in the beginning of the Hindu Zodiac—that these are called the *Satya yug*, the *Treta yug*, the *Devapar yug* and the *Cali yug;* the latter of which (that in which we live) consists of 432000 years, and that of these years 4925 had expired in A. D. 1824—the current one being the 4926th (of the Cali yug). We need therefore carry our present speculations no higher than the beginning of that æra, as the Tamul Astronomers are contented to do when they compute their Solar Kalendar.

ARTICLE 2.

Rule for finding the mean epoch of the commencement of the Tamul Solar year.

Duration of the Solar year *Vachij* 365d. 15g. 31v. 15p.

Sittandij 365d. 15g. 31v. 30p.

The Tamul Astronomers have adopted the Solar year of the Aria Siddhanta, the duration of which is 365^{d} 15^{g} 31^{v} 15^{p}, in preference to that of the Surriah Siddhanta which is 365^{d} 15^{g} 31^{v} 31^{p} 24^{s} (*), and as they generally work in Solar time, they use it also in their Lunar computations: but this is to be understood only of the Northern Tamuls, called *Vachij* by their Southern neighbours, (I suppose on account of their using the *Vakiam* process in their operations), for the latter, who stile themselves *Sittandij*, employ another Solar year, of 365^{d} 15^{g} 31^{v} 30^{p}, and make use of a Cycle of 90 years, the construction of which will be explained in a subsequent article.

(*) According to the Aria Siddhanta there are 1577917500 days (called *Yuga dina*) in a Maha yug or 4320000. Hence one year $=\frac{1577917500}{4320000}$d. =365d. 15g. 31v. 15p. Indian time, 365d. 6h. 12m. 20s. European time. According to the Surriah Siddhanta the *Yuga dina* is 1577917828, hence the year is $\frac{1577917828}{4320000}$d =365d. 15g. 31v. 31p. 24s. Indian time, and 365d. 6h. 12m. 36s. 34f. European time. And lastly, according to the *Sittandij*, the same expression is $\frac{1577917800}{4320000}$=365d. 15g. 31v. 30p. Indian time, and 365d. 6h. 12m. 36s. European time.

(*) 10 [illegible]

[illegible]

Rule for finding the Ahargana *or time elapsed from the beginning of the Cali yug to that of any proposed year.*

Rule for finding the *Ahargana.*

" Write the numeral of the proposed year in two places; multiply the first by 365¼ and the " second by 5. Subtract 1237 from the product of the latter, divide the remainder by 576, the " quotient will give *days*. Multiply the second remainder by 60 and divide again the product by " 576, the quotient will give guddias, and so forth to viguddias and paras.— Add the days, " guddias, &c. thus found, to the product of the numeral into 365¼, so shall the sum be the " *Ahargana* sought, i. e. the time expired on the day computed for, since the origin of the " Cali yug."

For the *Soota dina* or initial feria of the year, " divide the sum of days above found by 7, " the quotient will give the number of weeks expired, which neglect; and the remainder will be " the odd day, over complete weeks, which counted from *Friday* (the day on which the week was " supposed to end) will give the initial feria of the year sought."

N. B.—If after dividing the second term of the rule by 576, down to paras, there is no remainder, it is a proof that the operation was well performed.

EXAMPLE.

Let the year of the Cali yug 4847 current or 4846 complete, be proposed, wanted its Soota dina and time of the day on which it began.

1o
4846
365¼
24230
29076
14538
1768790
1211 30
1770001 30

2o
4846
× 5
24230
Sub.— 1237
22993
Div. by ÷ 576
Quotient 39 days.
With a remainder of 529
Mult. 60
31740
Divide by 576
Quotient 55 guddias.
With a remainder of 60

Continued.
60
Multiply 60
3600
Divide by 576
Quotient 6 viguddias.
With a remainder of 144
Mult. by 60
8640
Div. by 576
15 paras.
Without a remainder.

3o

	D.	G.	V.	P.
Product of No. 1	1770001	30		
of No. 2	39	55	6	15
Ahargana or Time expired	1770041	25	6	15

4o
7)1770041(252863 weeks.

Soota dina.

Remainder 0, which counted from Friday, leaves Friday for the initial feria, or Soota dina.

ANSWER.

The year of the Cali yug 4847 began on a Friday at $25^g\ 6^v\ 15^p$ after Sun rise, and as the guddias do not exceed 30, the Sydereal and Civil years begin on the same day.

Father Beschi, from whom I have borrowed this Rule, is silent on the Meridian to which it refers; it is therefore necessary to supply that omission.

The Hindus refer to two principal Meridians—those of *Lanca*, and of *Ramissuram*, more properly *Ram-Ishura.*

The Indian principal Meridians: Lanca, Ramissuram.

Lanca is an imaginary place supposed to lie under the Equator, somewhat S. W. of the Island of Ceylon; it is one of the four cities (*Yavacoti* being the first, *Lanca* the second, *Bornacoti* the third, and *Siddhapuri* the fourth) which are supposed to lie under the Equator at 90 degrees distance from each other.

The Tamul Rule refers to the Meridian of Lanca a place under the Equator.

The Meridian of *Lanca* is supposed to pass through two other towns on the Continent of India, namely, *Sannihita-saras*, and *Avanti*, the latter, according to common opinion, being *Ujjayini*, now called Oogein, which lies in 23° 11′ 30″ North Latitude.

That Meridian (in Sungscrete Rec'ha) is supposed to lie 75° 53′ 15″ ($5^h\ 3^m\ 33^s$) East of Greenwich; and 73° 33′ 0″ ($4^h\ 54^m\ 12^s$) East of Paris (*), and to this the preceding Rule refers.

Ramissuram is a small Island, situated between Ceylon and the Continent of India, at the entrance of Palk's passage in the Streights of Manaar, and is famous for its ancient Pagoda and Observatory.

It lies in 79° 22′ 5″ ($5^h\ 17^m\ 28^s\ 20'''$) Long. E. of Greenwich,

and 77° 1′ 50″ ($5^h\ 8^m\ 7^s\ 30'''$) East of Paris.

Its Latitude is 9° 18′ 7″ North.

N. B.—This position was extracted from Colonel Lambton's Trigonometrical Survey. (†)

Demonstration of the Tamul Rule for finding the Ahargana, and initial feria of the year, called Soota dina.

Demonstration of the Rule.

The first part of this operation, which goes to multiply the numeral of the proposed year of the Cali yug by $365\frac{1}{4}$, requires no demonstration; that multiplier including the 15 odd guddias (6 hours) over the number of entire days contained in the year, which, as was before stated, consists of $365^d\ 15^g\ 31^v\ 15^p$ ($365^d\ 6^h\ 12^m\ 30^s$ Eur. time). But we are to account for the remaining 31^v. 15^p. ($12^m\ 30^s$ Eur. time) by which the years of the Cali yug expired ought also to be multiplied.

Now, adverting to the process as disclosed at page 8, for the reason that the sum of years is

---

(*) Lanca may be supposed to lie very nearly South of Calicut, the Meridian of the latter place passing only 0d. 4m. 15s. West of the Rec'ha of Lanca.

(†) The Rules and Tables of Mulli-Carjanada, and Bulla-ditty Callu, refer to the Meridian of Ramissuram.

multiplied by 5, it follows that you are to take only the 1-5th part of 31v 15p or 1875p, that is $\frac{1875}{5}$p = 375p, or what is the same thing 6¼ viguddias.

Now to multiply successively the complete years of the Cali yug 4846 in terms of days, &c. we are to consider that 6¼ may be converted into this expression $\frac{3600}{576}$, the numerator expressing the number of minutes in a Tamul hour or *guddia;* and as the Rule goes to divide the product of the elapsed years multiplied into 5 by 576, we have $4846\times5\times\frac{3600}{576}=4846\times31\frac{1}{4}=\frac{24230}{576}\times$ $60\times60\times60$ in which expression the first factor gives the product in days, the second in guddias, the third in viguddias, and the fourth into paras.

We are now to enquire why, having multiplied the years of the Cali yug expired by 5, we have subtracted 1237 from the product.

Observe that, if that number be divided as before by 576 it will give 2d 8g 51v 15p, therefore, seeing that according to Hindu account the first year of the Cali yug began on the 4th day of the week at 51g 8v 45p, and that if 1237 be divided by 576 the quotient will give as above stated, if we add both

	D.	G.	V.	P.
as above stated, if we add both - - - - -	2	8	51	15
	4	51	8	15
we have a complete week - - - - - -	7	0	0	0

so that this equation is merely contrived for the sake of counting the days in the *Ahargana* from a complete period, i. e. the beginning of the week as it was then considered to be, and this addition will be equally performed, whether you add it to the year, or subtract it from the epoch, in which latter case however, it will be made to begin 2d 8g 51v 15p sooner than it ought, increasing the *Ahargana* by thus much, which is the cause of the subtractive equation when that element is computed by the Tables.

Having operated agreeably to the preceding Rules, you are to reckon from *Friday*, because it was then taken to begin the week.

But if you wish to reckon from *Sunday*, you are to subtract *two* days from the above account, which will be done if you retrench twice 576, or 1152, and if instead of 1237 you subtract 2389. The latter is the practice of the Southern inhabitants of the Peninsula, called *Sittardij*.

The Rule and Example given at page 8, as it includes the subtractive quantity 1237, is therefore to be expressed as follows:

	D.	G.	V.	P.
$\frac{4846x5-1237}{576}\times60g=\frac{22993}{576}=$	39	55	6	15
and this added to $4846\times365\frac{1}{4}=$	1770001	30	0	0
as before found - -	1770041	25	6	15

and we are to reckon from *Friday*. But if you wish to reckon from *Sunday*, it will be $\frac{4846x5-2389}{576}\times60g=\frac{21841}{576}=37^d$ 55g 6v 15p.

N. B.—It frequently occurs, in the course of research, that it is expedient to compare the *Ahargana* elicited by the Rule, with that which may be procured by means of the Tables. It is therefore necessary to warn the reader, that although the *Ahargana* used by the Northern Tamul Astronomers is constructed so as to reckon from *Friday*, yet if we seek the *initial feria* of the year, for the same account, by means of Table I. (page 1 of the Tables), we are to count the root of the days inserted between parenthesis, from *Sunday*, which is not the case when using Table XLVIII page 66, where the remainder after division by 7 is to be told off from *Friday*.

ARTICLE 3.

On the manner of computing the beginning and duration of the twelve months of the year.

In the present position of the Sun's Apsis *(Ravi-Mandocha)* which only moves at the rate of 1′ in 517 years, and which at the end of the year of the Cali yug 4846 (*) (A. D. 1745) was in $2^s\ 17^o\ 17'\ 10'',4$ from the first point of the Hindu Zodiac—and of the distance of the said point from the Equinoctial colure (Ayanansa) which increases 54″ in a year, and was at the end of the same year equal to an arc of $18^o\ 41'\ 23''\ 11'''$, the separate duration of each of the twelve months of the Solar year (in the aggregate always equal to $365^d\ 15^g\ 31^v\ 15^p$) was as follows:

	Bengal.	Tamul.			Bengal.	Tamul.	
	Solar Months.	Solar Months	Duration.		Solar Months.	Solar Months.	Duration.
			l g. v. p.				d. g. v. p.
1	Vaisacha	Chaitram	30 55 32 1	7	Cartiga	Arpesi	29 54 7 1
2	Jaish'ta	Viassei	31 24 12 1	8	Margasiras	Cartiga	29 30 24 2
3	Ashar.	Auni	31 36 38 1	9	Paushya	Margali	29 20 53 1
4	Sravana	Audi	31 28 12 2	10	Magh	Tye	29 27 16 1
5	Bha'dra	Auvani	31 2 10 1	11	Phalguna	Maussi	29 48 24 1
6	Aswina	Paratasi	30 27 22 1	12	Chitra	Poongoni	30 20 21 2

Now if it be required to find the Ahargana, and initial feria (Soota dina) in the beginning of each Solar month of the current year of the Caliyug 4847, having found the same for the beginning of the year by the general rule given at page 8 (or by means of Table I), all that need be done is to add successively thereto the *abstract* duration of each month, as above exhibited, and dividing as usual by 7, the remainder counted from *Friday* (or if the Table be used the Root between parenthesis from *Sunday)* will give the Soota dina sought.

How to compute the beginning and duration of the months.

The following example will answer for all possible cases, when computing in *Consequentia.* The quantities for each month must of course be subtracted when working in *Antecedentia.*

(*) 9th April N. S.

EXAMPLE.

By the Rule.	D.	G.	V.	P.	By the Tables.	D.	G.	V.	P.
Ahargana for the beginning of A. C. 4847	1770011	25	6	15	Initial Root of A. C. 4847	(5)	25	6	15
Abstract dur. of Chaitram	30	55	32	1	Table III.	(2)	55	32	1
Ahargana 1st Viassei	1770072	20	38	16	Monday	(1)	20	38	16
of Viassei	31	24	12	1		(3)	24	12	1
Ahargana 1st Auni	1770103	44	50	17	Thursday	(4)	44	50	17
of Auni	31	36	38	1		(3)	36	38	1
Ahargana 1st Audi	1770135	21	28	18	Monday	(1)	21	28	18
of Audi	31	28	12	2		(3)	28	12	2
Ahargana 1st Auvani	1770166	49	40	20	Thursday	(4)	49	40	20
of Auvani	31	2	10	1		(3)	2	10	1
Ahargana 1st Paratasi	1770197	51	50	21	Sunday	(0)	51	50	21
		&c.					&c.		

Here the process by the Table indicates at once *Sunday*; but if we had worked merely by the Rule for *the 1st of Paratasi*, it would be 7)1770197(252885 weeks
with a remainder of 2
which counted from *Friday*, gives equally *Sunday*.

ARTICLE 4.

On the Civil years of 365 and 366 days.

Before entering into the manner of expounding the initial feria of the Hindu Solar months for the European concurring date, we shall consider the effects of the operation of the fraction of days annexed to the number of *entire* days for each month, already hinted at page 4.

Year of 366 Civil days how discovered.

The number of registered days contained in any Solar month depends on the value of the fraction of the first *Ahargana* in the year, which is variable. This fraction combined with those of the remaining months (which abstractedly are constant) determines the *character* of th year, by which is meant whether the *Civil* is one of 365, or 366 days: because when the sum, or difference, for any month exceeds $59^g\ 59^v\ 59^p$, its initial feria passes suddenly from one day to its next.

		D.	G.	V.	P.
Thus if the beginning of Chaitram and Solar year be expressed by the Root - - - - - - -	Friday	(5)	53	13	47
And if you add thereto the collective Roots up to the month Tye V^o (Table III)		(4)	6	46	12
You have the *Soota dina* for Maussi ♒ - - -	Tuesday	(2)	59	59	59

Tuesday, which if expounded in the European Kalendar with the Dominical Letter F, as shall be shewn hereafter, will elicit *Tuesday* the 12th February *Sydereal account*.

	D.	G.	V.	P.
But if the same Root - -	(5)	53	13	47
be only encreased by - -	-	-	+	1
	(5)	53	13	48
and you add for Tye as before -	(4)	6	46	12
you have the beginning of Maussi	(3)	0	0	0

on Wednesday the 13th February; and so the month *Tye* which had before only 29 Kalendar days, would in the latter case count 30, and the following month Poongoni ♓, which had 30 days before, would now only count 29.

This circumstance, which generally operates so as to exchange the value of two near months, so that their sum remains the same, yet sometimes produces a different result, and determines a Leap or a common year.

		D.	G.	V.	P.
Thus let the Root for the beginning of Chaitram and year be -	Wednesday	(3)	59	59	59
And suppose that being expounded with the Dominical Letter G it brings out the 11th of April, add one para thereto - - - - - -					+1
	Thursday	(4)	0	0	.0

then you have *Thursday* the 12th April, and the Civil month Chaitram, which in the former case counted only 31 days, will now only count 30, without an equivalent in the next month.

When the Root of Chaitram exceeds 44g 28^{v} 44p the year is of 366 days.

But it will be further shewn that, whenever the Root for Chaitram and year exceeds 44g 28^{v} 44p the proposed year invariably counts 366 days; therefore in the present case, the said year would become a common instead of a Leap year, which it would have been.

Root for the beginning of Chaitram and year expounded into European time—an Index which shews whether the year consists of 365 or 366 days, and indicates the limits of the other 11 months.

Generally the European date concurrent with the beginning of Chaitram and year is an Index which points out whether the Hindu Solar year propounded, consists of 365 or 366 days in the Kalendar, which (to use common language) I shall in future call *Common* and *Bissextile*, altho' the latter do not recur by arbitrary intercalations, as is the case in the European Kalendar.

The same date also indicates the limits of the beginnings of the 11 remaining months of the same year, when referred to our Kalendar, in a manner that cannot be mistaken, notwithstanding the great variety of combinations of which the Roots are susceptible.

RULE.

How to discover a common year.

1° "Whenever the fractional part of the Root which elicits the beginning of the year falls "below 44g 28^{v} 44p, or up to it, then the year counts only 365 days in the Kalendar."

A Bissextile year.

2° "And when the fraction amounts to 44g 28^{v} 45p then that Civil year counts 366 days."

		G.	V.	P.
The demonstration of this precept flows from what has already been said: for let the fraction of the initial feria proposed be - - - -		44	28	45
Add the fraction of the Root for one year complete - - -		15	31	15
You have for the sum - - - - - -	1d	0	0	0

that is, one entire day over and above the sum of days independently of the fractions.

EXAMPLE I.

		D.	G.	V.	P.
On the beginning of the year of the Cali yug 4856 (A. D. 1754), the initial Root is found to be - - - - - - -	Tuesday	(2)	44	47	30
which if expounded with its Dominical Letter F, will give 9th April N. S.					
Now if you add thereto the Root for one complete year (Table I) - -		(1)	15	31	15
You have beginning of - - - - -	Thursday	(4)	0	18	45

the year of the Cali yug 4857:

which Thursday being expounded with its proper Dominical Letter E, falls on the 10th April 1755, and shews that the year of the Cali yug 4856 (or Saca 1677) counts 366 days in the Kalendar.

EXAMPLE II.

		D.	G.	V.	P.
But if the year of the Cali yug 4882 (A. D. 1781), the proper Root of which is - - - - -	Monday	(1)	43	51	15
be proposed, and this Monday be expounded with the proper Dominical Letter G, it will fall on the 9th April N. S. Add as before the Root for one year - - - -		(1)	15	31	15
And you have the beginning of - - -	Tuesday	(2)	59	22	30

the year of the Cali yug 4884. Now the said initial feria being expounded with the proper Dominical Letter F, falls also on the 9th of April N. S. (A. D. 1782), and the corresponding Christian year being a common one, the Tamul Solar year is one of 365 days.

Having calculated by these Rules the Tamul Leap years of 366 days concurring with the Christian year of the XIXth Century, they were found to fall as follows:

Number of Leap years.	Christian Years.	Leap Years of the Cali yug concurring with do.	Years from the birth of Salivahana.	Number of Leap years.	Christian Years.	Leap Years of the Cali yug concurring with do.	Years from the birth of Salivahana.
1	1801- 2	4903	1724	14	1851-52	4953	1774
2	1805- 6	4907	1728	15	1855-56	4957	1778
3	1809-10	4911	1732	16	1859-60	4961	1782
4	1812-13	4914	1735	17	1863-64	4965	1786
5	1816-17	4918	1739	18	1867-68	4969	1790
6	1820-21	4922	1743	19	1870-71	4972	1793
7	1824-25	4926	1747	20	1874-75	4976	1797
8	1828-29	4930	1751	21	1878-79	4980	1801
9	1832-33	4934	1755	22	1882-83	4984	1805
10	1836-37	4938	1759	23	1836-87	4988	1809
11	1840-41	4942	1763	24	1890-91	4992	1813
12	1843-44	4945	1766	25	1894-95	4996	1817
13	1847-48	4949	1770	26	1898-99	5000	1821

Thus there happen to be 26 Leap years in the XIXth Century, instead of 25 as is the case in the Julian, and 24 in the Gregorian Kalendars (when the latter does not begin with a Bissextile year, as A. D. 1600, 2000, &c.) which will serve to explain hereafter, why the Julian Kalendar recedes, by one day, and the Gregorian two days, from the Tamul Secular years.

ARTICLE 5.

The limits of the beginning of the 11 last months how discovered.

On the limits of the number of Civil days contained in the eleven last months of the year.

With respect to the beginning of the eleven last months of the year, and the manner of determining the number of civil days contained in each in any particular year, the initial root of the year affords likewise an Index from which the beginning of the eleven last months never recede (in their proper concurrent European month) more than *two days*—and never exceed beyond *four*: and furthermore shews, that in the present positions of the Sun's Apsis, and Equinoctial Colure, the Tamul month *Maussi* ♒ (Indian February) is alone, and invariably that which anticipates the European date of the beginning of Chaitram in the New Style. (*)

The limits of Maussi constant in the Gregorian year, always —.

Thus if the 1st *Chaitram* and year of the Cali yug 4847 be found to fall on the 9th April 1746 N. S. the beginning of the month of *Maussi* will fall on the 8th February 1746—and if the 1st *Chaitram* and year of the Cali yug 4918 falls on the 10th April 1816 N. S. the 1st of its month *Maussi* will fall on the 9th February 1817; and *no other month* in the year will be subject to the same subtraction.

Those of the other 10 months always +4

This consideration reduces the limits of the other ten months (in their concurrent European months) to the compass of four days, to be added to the date of Chaitram in its proper European month.

Thus if the 1st Chaitram of the year of the Cali yug 4915 falls on the 11th April 1813 N. S. none of the other months in the same year will begin later than the 15th of its own concurring European month, or earlier than the 11th.

These limits being *less than a complete week*, never leave the least doubt, when converting Tamul into European dates, into which of the four weeks and fraction of week the initial feria of any Tamul month elicited by the Rule, should fall according to European account.

How to determine the Civil and Sydereal duration of each Tamul month of any proposed year.

With respect to the Sydereal and Civil duration of the Tamul months of any proposed year, it is manifest that since the initial feria of each month may be elicited by the Rule or the Tables, and since we possess the limits within which these must fall, any European Kalendar, or series of Dominical Letters, will suffice for determining the length of the proposed month.

Thus let it be proposed to find the Sydereal and Civil duration of the Tamul month Auni of the year of the Cali yug 4856 (A. D. 1754-5). Having computed the initial feria and fraction for that month according to the preceding Rules, which are (vide Table D. G. V. P.
X, page 13) - - - - - Tuesday (2) 4 31 32
and that for the following month Audi - - - Friday (5) 41 9 33
and the Dominical Letter for A. D. 1754 N. S. being F (†), if we take Tuesday (A) to be the

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(*) In the Old Style *Maussi* falls always *one day* and Poongoni *two days* (in their respective European concurring months) behind the date of Chaitram, in its own European month; but the extreme limits continue to be *five* days, because the other ten months cannot exceed the European date of Chaitram in their proper concurrent month, more than *three* days.

(†) Any Dominical Letter assumed at pleasure will answer the same purpose for the abstract duration of the month without any reference to the European Kalendar.

1st of Auni, and count down to the Friday (D) which falls between 28 and 32 days, we find that it corresponds to the 32*d day*, *Tuesday counted as one*, which marks the first day of the Tamul month *Audi*, and consequently that *Auni* (the month for which the computation is made) contains 31 days.

Now the fraction of time annexed to the initial feria of *Auni* is 4g 31^{v} 32^{p} which being below 30 guddies (page 4), shews that the month begun at *day time*, and therefore the Sydereal and Civil beginning coincide.

But the fraction of the initial feria of *Audi* is 41g 9^{v} 33^{p}, which shews that the month began at *night time*, therefore the *Civil* month commenced not on *Friday*, but on *Saturday* following, the Civil and Sydereal account differing by one day—therefore the Sydereal month *Auni* is of 31 days and the Civil of 32.

This method is so plain, that although the proposition presents three feasible cases, viz. 1^{o} When the Roots are both below or above 30g, when the Civil and Sydereal months are of *the same duration*. 2^{o} When the Root of the first is below, and that of the second above 30g, in which case the Civil is *greater* than the Sydereal; and 3^{o} When the first is above, and the last is below 30g, in which case the Civil is *shorter* than the Sydereal month, yet the process being always the same, hardly requires any further illustration. For it is plain that if we wish to refer the same to the European Kalendars, provided the Christian date of the *initial feria* of the year, and the Dominical Letters according to either Old or New Style be given, then the date of beginning and duration of the twelve months of the Tamul years may always be known by their Roots without difficulty.

Thus if the initial root of the year of the Cali yug 4856 be *Tuesday* (2^{d}) 41g 47^{v} 30^{p}—the Dominical Letter for A. D. 1754 *Old Style* be B; and the date of the above Tuesday 29th of March, the Root for the beginning of *Viassei* being *Friday* (5^{d}) 40g 19^{v} 31^{p}, if we proceed as shewn before, it will be found to fall on the 29th April, and (counting Tuesday as one) the Tamul month *Chaitram* will consist of 31 days *Sydereal* and *Civil* account.

And if the same be computed for the New Style, the Dominical Letter for 1754 being F, then, if *Tuesday* 1*st Chaitram* is said to fall on the 9th April N. S. *Friday*, the initial feria of *Viassei* will fall on the 10th May, and the first Tamul month will consist of 31 days.

Lastly, it is to be remembered when reckoning according to Civil account, that if the Civil month begins one day later than the Sydereal, it displaces *by one*, every succeeding day in the same month, and this until the Sun, by entering a new Sign, determines the future coincidence or dissidence of the Civil and Sydereal dates of the ensuing month.

What we have hitherto stated on the general construction of the Solar Sydereal year, will be frequently referred to in the course of this work, when it comes to treat of the resolution of the

Astronomical Luni-solar year by means of the *Vakiam* process, and Tables, such as it is used by the modern Tamul Astronomers; differing in this respect from the Tellingas, who still adhere rigidly to the doctrines of the Surriah Siddhanta.

The Tamul Kalendar is in itself as simple as the European, but as its columns record true time for the particular place where it is intended to be used, and as its margin is loaded with a variety of articles foreign to its immediate purpose, which require a greater knowledge of Hindu Astronomy, than the reader is at present supposed to possess, it is indispensable, in order to render that acquirement practically useful, to furnish him with the means of converting dates proposed according to the Hindu Solar account, as explained in the preceding pages, into corresponding European dates and vice versa, and to that object we shall devote the remaining part of this Section.

Should, however, the reader be desirous to inspect a specimen of the Ravi-Panchangum, or Solar Kalendar as it is published in the Southern parts of the Peninsula of India, he will find a translation of that part of it which refers to the first month of the year of Cali yug 4926 (A. D. 1825), inserted at the end of all the Tables; for we have already occasion for a greater number of technical terms in the present Memoir than is convenient, without adding to these a number of Astrological definitions, which cannot be dispensed with for understanding the *Addenda* of the Ravi Panchangum.

ARTICLE 6.

The manner of numbering the Indian years of the Cali yug, when referred to European accounts.

Of the æra Cali yugam.

The number of years expired since the beginning of the Cali yug on the birth of Christ, *Dyonisian* account, are 3101; therefore, the *current* year A. D. 1 corresponds to *part* of the 3102d year of the Cali yug.

It will save a great deal of future embarrassment to the reader if he notices particularly at this place, that according to established usage, the years of *all the Hindu Styles* are said to concur with that Christian year *during which the last expired ends*. Thus if the years of the *Cali yug*, or *Saca*, which correspond to A. D. 1822 be asked of any Indian, he will call it 4923 *complete*, because that Solar year ends on the 11th April N. S. of the said Christian year. But as the current Indian year 4924 begins on that day, and continues until the 11th April 1823, it might otherwise be more properly coupled with the latter.—It is therefore a general rule, when any year of the Cali yug is to be deduced from the numeral of the European year to which it corresponds, that *unity* be subtracted from the latter before adding the epoch thereto; which is the practice followed by *Father Beschi*, and that which is used in the Examples given at the end of this Memoir.

1822
3101
————
4923

For the numeral of the year of the Cali yug, unity to be retrenched from the European year before adding the epoch 3102.

1821
3102
————
4923

Article 7.

Of the æra Salivahana.

Æra Salivahana.

The beginning of the æra Salivahana dates from the birth of a Prince of that name whose history is connected with Hindu Mythology: that event is supposed to have taken place when 3179 years of the Cali yug had expired, which makes it fall 78 years after the birth of Christ.

The years when reckoned according to that account are called *Saca*, but differ in nothing from the common Solar year, the elements of which were disclosed in the preceding pages. It is customary in these Provinces, (and I believe in all parts of India) when dating any document, to couple the numeral of the year *Saca* with that of the Cali yug. Thus if the current year be asked of any Native, he seldom fails (besides other distinctions) to say, for instance "The year 4782 of the Cali yug, or Saca 1603."

Modern Astronomers make frequent use of this æra for abridging certain Astronomical computations, as will be seen hereafter in the article which treats of the Cycle of 60 years.

The current year Saca may always be determined by the following

Rule.

For the numeral of the year Saca.

Let the year of the Cali yug complete be proposed - - - - subtract 4846 3179

Year Saca complete - - - - 1667

Let Anno Domini current be proposed - - - - - - subtract 1745 78

Year Saca complete - - - - - - 1667

Or if you wish to have the three successively by one operation for A: D. 1745 current, say first 1745—1=1744 - - - - - 1744

Add the year of the Cali yug expired - - - 3102

At the birth of Christ, you have A. Cali yug - - 4846 complete

Subtract epoch of Salivahana - - - 3179

You have the year Saca sought - - - - 1667 complete

and let it be remembered that the Christian year proposed concurs partly with the years of the Cali yug 4846 and 4847, and Saca 1667 and 1668, in the same manner that the first of each of these years corresponds partly with A. D. 1745 and 1746.

Article 8.

Of the æra Vicramaditya.

Of the æra Vicramaditya.

There is another æra called *Vicramaditya*, little used in the Southern parts of India. It numbers the Luni-solar years, in the same manner as that of *Salivahana* does the Solar ones.

Vicramaditya is said to have been a Prince who reigned 135 years before *Salivahana*, and supposed to be one of his ancestors. Its epoch begins when 3044 years of the Caliyug were expired, i. e. 57 years before Christ; so that if any year of the Cali yug be proposed, and the last expired year *Vicramaditya* be wanted, which let it be A. Cali yug 4925, subtract 3044 therefrom, you have 1881, the year sought. Or if the Christian year be proposed, which let be 1824; add 57, and you have 1881 as before.

Article 9.

Practical manner of determining the commencement of the Solar year.

Practical determination of the beginning of the Solar year.

In order to dismiss what may be farther stated on the mode of determining the beginning of the Solar year, I shall observe, independently of all computations, that there are several ways of fixing the same practically. These consist in observing the passage over the Meridian of some *yoga*, or Zodiacal Star (the principal one of each Lunar mansion) the position of which is given in the Hindu Tables.

Manner of determining practically the beginning of the Solar year.

By the yoga Hershana or Spica Virginis.

Thus *Hershana*, the yoga of, and only Star in the Lunar mansion *Chitra*, is accounted by the Hindu Astronomers to be exactly six Signs in Longitude from the beginning of the Solar Zodiac. European Astronomers take this Star to be *Spica Virginis*; so that when it is observed to pass over the Meridian at midnight any where, the mean Solar year ought to begin: altho' modern Astronomers account its Civil commencement to be on the ensuing Sun rising.—Whether the original position of the Star in Right Ascension and Declination from which the Hindu Astronomers have deduced its Longitude, have been wrongly determined, as is most probable, or that they advert to another Star, our determination of the first point in the Indian sign *Aries* by *Spica Virginis*, gives a material difference in the results.

I have computed its Longitude for the year of the Cali yug 3600 complete, answering to 18th March A. D. 499, when it is supposed there was no *Ayanansa*, and also for A. C. 4911 complete, when the *Ayanansa* was 19° 39′ 54″ using De Lalande's Tables, and the difference at the respective epochs were

Longitude Spica Virginis 20th March 499	6s	2°	47′	50″	53‴
By the Ayanansa for Solar year Cali yug 3600 complete	6	0	0	0	0
Difference		2	47	50	53
Longitude of Spica Virginis 29th March 1810 *Julian Style*	6	21	11	32	55
By the Ayanansa for the year of the Cali yug 4911 complete	6	19	39	54	2
Difference		1	31	38	55

By which quantities the yoga *Hershana* exceeded at the respective epochs the Longitude ascribed to it, a circumstance which would have retarded the beginning of the Solar year of the Cali yug 3501 by $2^d\ 20^h\ 7'$—and that of 4912 by $1^d\ 13^h\ 11'\ 36''$.

The same by the yoga Vaidhrity.

Independently of *Hershana*, the yoga of the Lunar mansion Revatí, supposed to be the same (*) as ζ Piscium, and called by the Hindus *Vaidhrity*, is taken by them to be in the last point of the sign *Min*, the Indian *Pisces*; or what comes to the same in the first of *Mesha* (Aries), so that

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(*) Some pretend that this coincidence took place 39 years later; but with these contending opinions we have at present nothing to do.

when it is supposed to pass the Meridian any where at midnight, it should mark the mean Sydereal beginning of the Tamul month *Arpesi*, from which that of the year may be deduced; but I believe that in present times Indian Astronomers make little use of any Star for improving their account of time, or their general system of Astronomy (*), and that they content themselves for all purposes, Civil as well as Astronomical, to observe the heavens in their Books and Tables. There can be little doubt that this opposition of *Hershana* (Spica ♍) and coincidence of *Vaidhrity* (ζ Piscium) to and with the commencement of the Hindu Solar Zodiac, never had the precision which the Indians assign to them; enough has been said, however, to shew that the manner of fixing the commencement of the Solar year indicated in the Rule given at page 8, causes it to anticipate in present times the moment of the Sun's entrance into the sign Mesha (♈) *according to their own Ayonansa*, by an assignable quantity of no difficult resolution.

SECTION II.

Account of the Tables.

This Section is exclusively confined to the consideration of the various processes and Tables by means of which the initial *feriæ or roots* of the beginning of Tamul years and months, treated of in the preceding Section, may be expounded into *monthly dates*, of the Christian Kalendars, for any epoch whatever; without which Hindu Astronomy can only be to Europeans a subject of learned discussion, the resolution of which can be of no sort of assistance for penetrating into the depths of Hindu Chronology, or for affording Indians any means for getting access into ours.

The following subject, although of vital importance to the utility of the rest of the work, will therefore neither gratify the curiosity of scientific men, nor serve to elicit the polemic powers of Scholiasts. The Rules and Tables hereafter disclosed consider both the Julian and Gregorian accounts: the first of these could not be dispensed with, because the Julian Style was only discontinued on the Continent of Europe on the 4th October 1582, when ten days were retrenched

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(*) There will be found a Note at the end of the Volume, wherein it is shewn how the beginning of any Hindu Solar year, as accounted in the Ariah Siddhanta, may be so equated that the Sun's mean Longitude, as elicited by the European Tables for that instant of time, be in all cases equal to the *Ayonansa* due to the proposed year. Now having equated the time of beginning of the Solar year 3601 (A. D. 409) by the formula given in that Note, the equation was found to be 2d 11h 10m 57⅓s. Eur. Time, or Indian Time - - - - - - - - - D. G. V. P. + 2 28 12 24

But the equation by *Hershana* was 2d 20h 7m or - - - - - + 2 50 17 30

Hence there is still a difference of - - - - 22 5 6

or in European Time 8h 50m 2s.

from the said month, and until the 29th March 1752 when the same style was adopted in England, and eleven days were retrenched for the same reason as had determined the Gregorian reformation.

The Dominical Letter.

The first step towards the attainment of that object is, to establish some expeditious method for expounding the monthly date of any feria (or weekly day) that may be proposed in past, present and future times, according to the two European accounts above mentioned; and the most obvious instrument for that purpose is the *Dominical* Letter. But as the usual process for eliciting it is somewhat operose (*) and would take a great deal more time than the whole resolutions of the problem, I have constructed two Tables which, in the space of less than three minutes, will enable the computer to elicit the same, for any year whatever, with equal certainty.

Explanation of the Tables.

I shall now proceed to give an account of the Tables belonging to the present Memoir.

Table I *and* II, *page* 1 *and* 2 *of the Tables.*

I notice these two Tables together, because they are both of the invention of *Father Beschi*, and are found in the same page of his manuscript tract on the *Division of Time* according to the Tamuls. The first I shall consider in the present article; the second will be noticed in that which treats of the Cycle of 90 years, used in the Southern Provinces.

Table I.

Table I gives at top of the 1st column, the Root of the *Ahargana* for the year of the Cali yug 4802, complete; the other quantities in the second column are the Roots of years from 1 to 100 collectively taken, the figures between parenthesis being the remainder of the sum of days after division by 7, to be counted from Sunday in order to have the initial feria sought.

If therefore it be proposed to compute the end of any year of the Cali yug, which let it be 4846, take 4802 therefrom; and if to the quantity which marks the epoch in the 2d column you add 44 years (the difference), the sum will be the Root of the end of the year 4846, or commencement

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(*) The following technical Rule in artificial verse, extracted from Hutton's Dictionary, will enable the reader to use that of the processes which he prefers, observing that the Dominical Letters of the ancient Julian Kalendar is 4 places before that of the Gregorian, the Letter A in the former answering to D in the latter. (Mathematical Dictionary, vol. I. page 395)

"Divide the centuries by 4; and twice what does remain
"Take from 6; and then add to the number you gain
"Their odd years and their 4th; which dividing by 7,
"What is left take from 7, the letter is given."

N. B.—The Julian and Gregorian Dominical Letters for every year from A. D. 1600 to 1900 being given in the Solar General Table, the trouble of finding the same either by Hutton's rule, or that indicated in the text, becomes unnecessary, for any of the years of the XVIIth, XVIIIth, or XIXth centuries.

of 4847; and if from the latter you subtract 3102 you will have 1745, the year of Christ corresponding thereto.

But as Beschi always computed the end of the Indian Solar year by means of the Christian one, in order to elicit the former *complete*, he retrenched one year from the latter, and used 3102 the current year of the Cali yug, instead of 3101 the last expired on the birth of Christ, as has been observed at page 17. The epoch given in Table I as that for 1700, is therefore truly that due to 1701.

EXAMPLE.

Let the beginning of the Tamul year which concurs with A. D. 1745 Gregorian Style, be required.

The year of the Cali yug for computation, as was shewn at page 17, will be 1745—1=1744, or 1744+3102=4846 complete, if we use Table I; but if Table VII (page 9), it will be 1745, both of which we will use once for the sake of exemplification.

By Table I.

	D.	G.	V.	P.
Epoch A. D. 1700 -	(6)	2	11	15
40 -	(1)	20	50	0
4 -	(5)	2	5	0
Root	(5)	25	6	15

By Table VII.

	D.	G.	V.	P.
Epoch Cali yug 4802 -	(4)	46	40	0
40 -	(1)	20	50	0
5 -	(6)	17	36	15
of Abargana	(5)	25	6	15

which being counted from *Sunday* indicates Friday the initial feria of the month Chaitram and year 4847 of the Cali yug. The reader may therefore, use either Table as may best suit his convenience.

It need hardly be said, that the quantities in the second column are the Roots for one, two, three, four, &c. years, after division of the days by 7: thus $\frac{365}{7}$=52 weeks + (1) day, the Root for one year independently of the fraction 15g 31v 15p, and 365d 15g 31v 15p×100=36525d 52g 5v 0p and $\frac{36525}{7}$d.=5217 weeks with a remainder of (6) being the Root for 100 years, independently of the fraction 52g 5v 0p.

Table III, *page* 3 *of the Tables*.

The contents of this Table will be better learnt by inspection, than by any explanation. I shall briefly state at this place, that in the first column will be found the *abstract* duration of each of the twelve months of the year according to the Aria Siddhanta, and as reckoned by the modern Hindu Astronomers, in the present position of the Sun's Apsis and Ayanansa.

In the second column will be found the Roots of the same as already explained, and in the third, are registered the collective Roots of the months as they advance in the year.

	D.	G.	V.	P.
Thus the abstract duration of Chaitram (♈), and consequently its end, being indicated by the Root - - - - -	(2)	55	32	1
And the duration of Vyassei ♉ being - - - -	(3)	24	12	1
	(6)	19	44	2

the collective Root for the end of Vyassei will be $(6)^{d}\ 19^{g}\ 44^{v}\ 2^{p}$ which is the second Root entered in the third column oopposite to the Tamul month *Vyassei*, and Hindu month *Jyaishtá*, the *Sun* being then leaving the Sign *Vrisha* ♉, and entering *Midhuna* ♊.

The utility of the third column need not be insisted upon; for it is manifest that if the Root for the end of the Solar month Auvani, or the beginning of the following month Paratasi were required, and if the *positive* Root of the 1st Chaitram and year for A. C. 4847 were, as before found (page 22), you need only take out of the 3d column the collective Root, and adding both, you have at once the Root for the beginning of *Paratasi* of the said year, instead of having to add successively those for *Vyassei*, *Auni*, *Audi* and *Auvani*, found in the second column.

	D.	G.	V.	P.
were required, and if the *positive* Root of the 1st Chaitram and year for A. C. 4847 were, as before found (page 22) - - -	(5)	25	6	15
You need only take out of the 3d column the collective Root - -	(2)	26	44	6
And adding both, you have - - - -	(0)	51	50	21

Table IV, *page* 5 *of the Tables.*

This Table serves to convert hours, minutes and seconds, from one sort of time to the other. It is calculated on the respective European and Hindu division of the day, the former into 24 hours, the latter into 60 guddias, subdivided sexagesimally into viguddias, paras, suras, &c. It requires no particular explanation, and the example given at the foot of the Table will suffice to shew its application.

Table V, *page* 6 *of the Tables.*

It may justly be observed, that the Dominical Letter being a contrivance of European invention, and the manner of finding it for any year that may be proposed being known to the meanest Almanac maker, a separate article on that subject in this work appears superfluous. On due consideration, however, I found it so essential to the resolution of all Hindu problems of Astronomy and Chronology, and the methods now in use for expounding it so very tedious, that I could not dispense from treating of it in a particular manner before entering into the practical part of this Memoir.

Feriæ beginning the centuries.

Table V is divided into two parts, the first of which shews the Dominical Letter, and day of the week beginning each Julian Secular year from A. D. 0 to 2000; or from A. Cali yug 3102 to 5102.

The second part shews the same for the *Gregorian* Secular years from A. D. 1500 (before which epoch that Cycle was unknown) to A. D. 2000; or from A. Cali yugam 4602 to 5102, which I call the initial *feria* of the century from which the commencement of the Hindu odd years, cannot deviate more than 3 days of the *Julian*, and 4 days of the *Gregorian* Kalendars.

The last section of this Table exhibits the same data from A. D. 0, to A. Ante Christum 4004, the epoch of the Creation, according to European Chronology: concurring with A. Ante Cali yugam 903-2.

Table VI, *page* 8 *of the Tables.*

Feria which begins the proposed European year.

This, like Table V, is divided into two parts, the first of which gives the number of days to be added to that which begins the century, in order to have the weekly day on which any of its odd years begin, according to the Julian Kalendar. The second part gives the same according to the Gregorian Style; and both give furthermore the day to be subtracted from the weekly day which begins the century, according as the years are Common or Bissextile, *for any year before Christ*, Julian Style. (*)

The figures in the body of this Table are so disposed, that they correspond to the number of days (0. 1. 2. 3. 4. 5. 6.) in the transverse column at top, which shews the number of feriæ to be applied as before said.

It may be expedient to warn the reader in this place, that the application of these Tables is much more simple than their necessary explanation seems to imply. Attention is only to be paid whether the date is to be expounded in *old* or *new* style, *before* or *after* Christ, to prevent confusion. The process according to the various cases is the same, the side of the Tables only varies. But as the mechanism of this Memoir hangs principally on Table V and VI, an attentive perusal of the following examples is recommended.

EXAMPLE I. *(Julian Style).*

How to determine the weekly day on which the European year begins, and deduce the Dominical Letter therefrom.

Let it be required to determine on what *weekly day* the year 1745 O. S. begins, in order to deduce the Dominical Letter therefrom.

1º Table V shews, part 1st, that the Julian year 1700 began on a *Monday* (the initial feriæ of the XVIIIth century). Now referring to Table VI, part 1st, with 45 odd years, you will find over it in the transverse column at top the figure 1, which shews that one day is to be added to Monday, in order to have the feria beginning the Julian year 1745: i. e. *Tuesday*.

Table IX, page 12.

Having got this step and using any Kalendar wherein the Dominical Letters are inserted (vide Kalendar at the end) and taking the first letter A (which always begins the year) to represent *Tuesday*, you find that the Julian Dominical Letter for A. D. 1745 is F; and consequently that for the ensuing year, (which is necessary for expounding the three last months of the Tamul year) will be E.

2d Part.

Let the Dominical Letter for the same year be required according to the Gregorian Style.

Table V, part 2, shews that the 18th century began on a *Friday* (the feria for A. D. 1700).

With 45 odd years refer to Table VI, part 2d, you find over that number in the transverse column at top, 0; which shews that A. D. 1745 Gregorian Style, also begins on a *Friday*.

(*) The years after Christ do not require that distinction.

(†) This Table is in all cases to be entered with the proposed *odd* Christian year, over a complete century.

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Any Kalendar will therefore shew that since A (the first Letter in the year) represents *Friday*, C is the Gregorian Dominical Letter for the proposed year 1745, and that B is that for the following year 1746.

Example II.

The same for the feria beginning A. D. 1815, *Julian* Style.

By Table V, part 1st, the 19th century begins on a *Sunday* (the initial feria for A. D. 1800) (*).

Referring to Table VI, part 1st, with 15 odd years, you find 5 over it, to be counted from *Sunday*, i. e. *Friday*, the feria beginning the proposed year; which shews as before, that the Dominical Letter, Julian Style, is C, and the following BA, because 1816 is a *Leap year.*

2d *Part (Gregorian Style.)*

By Table V, part 2d, the 19th century begins on a *Wednesday*: and by Table VI, part 2d, (†) 15 odd years give 4, to be counted from Wednesday; therefore the year 1815, Gregorian Style, begins on a *Sunday*, and the Dominical Letter is A, and the following year 1816, is GF, for the same reason as before stated.

Observation.

As the 17th, 21st, 25th, 29th and 33d centuries, Gregorian Style, *begin* with Bissextile years, the 1st part of Table VI, instead of the 2d, is to be used, because from that circumstance these years are assimilated to the *Julian* Style, the Secular years of which are all Bissextile.

For the Gregorian years
1600
2000
2400
2800
3200
the 1st part of Table VI is to be used.

Example III *(Gregorian Style.)*

Let the beginning of the year 1601 N. S. be proposed.

Table V, part 2d, shews that the 17th century begins on a *Saturday* (the initial feria for A. D. 1600).

But Table VI, *part 1st*, for 1 odd year, gives 2, which added to *Saturday*, gives *Monday*, which is the weekly day beginning the year 1601, and whose Dominical Letter is therefore *G*, and that for the following year *F*.

Example IV.

Let the beginning of the year 1699 N. S. be proposed.

Table V, *part 2d*, shews that the 17th century begins on a *Saturday*.

But Table VI, part 1st, for 99 odd years gives 5; which added to Saturday, shews that the feria beginning the year 1669, is *Thursday*; and consequently the Dominical Letter for that year, *Gregorian Style*, is D, and the following one C.

(*) With A. D. 1800 refer to Table V, part 1st, and you find in column 3d that the 1st January of the said year falls on *Sunday* Julian Style: the Dominical Letters being AG.

(†) With the same year refer to Table V, part 2d, and in the first column you find *Wednesday*, which is the initial feria of A. D. 1800 Gregorian Style: the Dominical Letter for that year being E.

Thus a very expeditious method has been instituted for finding the Dominical Letter, and expounding all the months and days in any given year since the birth of our Saviour, according to both European accounts, so that the only further attention which is to be paid, is to notice whether the year that follows the proposed one (the Dominical Letter of which is required for expounding the beginnings of Tye ♑, Maussi ♒ and Poongoni ♓), be a *Common* or a *Bissextile* one.

Attention to be paid to the Dominical Letter of the following year, whether it be *Common* or *Bissextile*.

We are now to consider *how the Dominical Letter for* any year before Christ, is to be determined; and this is *also done* by help of Table V and VI, with the following modifications.

Expounding of Dominical Letters for any time before Christ.

As the years are counted *increasing* when *ascending* from the birth of our Saviour, instead of *descending* and *increasing* in the contrary case, the numbers to be taken out of Table VI, part 1st and 2d, are to be subtracted from, instead of added to, the weekly day commencing the century, for having that which begins the given year. The following Rule will provide for this case.

Rule.

1º If the given year be a *Common one*, use part 2d of Table VI.

2º If the given year be a *Bissextile one*, then use part 1st of Table VI.

Example V.

B C a common year.

Let the Dominical Letter for the year before Christ 550 be proposed. That year not being divisible by 4, without a remainder, is a *Common one;* therefore part 2d, Table VI, is to be used.

By Table V, part 3d, we find that the year before Christ 500 (Julian Style) begins on a *Tuesday*, and Table VI, part 2*d*, for 50 years gives 6, to be *subtracted* from *Tuesday*, i. e. *Wednesday*; therefore the Dominical Letter for the year 550 (the 50th of its own century) is E, and that for 549 is **D.**

Example VI, *page* 8 *of the Tables.*

B C a Bissextile year.

Let the Dominical Letter for the year 636 before Christ be proposed. That number being divisible by 4, without a remainder, the year is Bissextile, and therefore part *1st*, Table VI, is to be used.

Now Table V, *part 3d, shews that the year before* Christ 600 began on a *Wednesday*, and Table VI, part 1*st*, for 36 years gives 3 to be subtracted from *Wednesday*, i. e. *Sunday*, therefore the Dominical Letters for the year 636 Ante Christum are **AG.**

N. B.—The cause of this difference is occasioned by the order of the years counted before Christ being reversed, and that the second Letter when the year is Bissextile, is to be taken in *Antecedentia*, instead of *Consequentia*, as is done for years after Christ.—Thus, if G were the Letter produced by the Rule for years before Christ, the second Dominical Letter would be F; but in ascending from the same, that Letter will still be G (as given by part 1st, Table VI), and the second Letter must be A. If we use part 1st, instead of 2d, there will be no possibility of a mistake.

How to determine the monthly by means of the weekly date.

Having thus found means to elicit the Dominical Letter for any given year in all possible cases and styles, there remains no difficulty for finding the feria on which any monthly date of the same year may fall. But the converse of the proposition is by no means so apparent, because as we have seen, the manner of fixing the beginning of any year or month, according to the precepts of Hindu Astronomy, whether Lunar or Solar, is by determining the feria on which such an occurrence falls ; and as there are four weeks and a fraction in every month, there is a doubt on which of these, the weekly day elicited by the Rule may fall.

For the resolution of this problem we are to have recourse to the General Index, the theory of which was given Article 5, page 15, and to Table V and VI, as shewn in the following examples.

EXAMPLE I.

Suppose that we have found by the Rule given at page 8, that the 1st Chaitram and year 4830 fell on a Sucra-vara (Friday), what may the monthly date of this Friday be?

I.

For the Dominical Letter, and the Christian year to be registered, we have 4830—3102=1728, and let the *Julian* date be first required.

Resolution of the European date by means of the weekly date of the Hindu Rule.

Beginning of the year.

II.

Table V, part 1st, shews that the 18th century began on a *Monday*.

Table VI, part 1st, for 28 odd years, gives 0 ; therefore the year 1728 began also on a *Monday* and the Dominical Letters (the year being a Bissextile one) are GF.

III.

Again Table V, part 1st, shews that the year Cali yugam 4802 current (corresponding to our Secular year 1700) begun on the 28th March O. S. and the year 4902 on the 29th of the same month, therefore the Friday sought must fall within two days of either of these two dates, and referring to the Kalendars, it is found to fall on the 29th March O. S. Q. E. In.

EXAMPLE II.

The same, Gregorian Style.

I.

Table V, part 2d, shews that the 18th century New Style, began on a *Friday*.

Table VI, part 2d, for 28 odd years gives 6 days, therefore the year 1728 began on a *Thursday* and the Dominical Letters were DC.

II.

Again Table V, part 2d, shews that the year Cali yugam 4802 began on the 8th of April, and 4902 on the 10th of the same month, therefore 4830 must have begun within two days of these limits; and referring to a Kalendar we find, that the given Sucra-vara (Friday) fell on the 9th April 1728. Q. E. I.

Examples might be multiplied, but as the process (which is extremely simple) is in all cases the same, I shall turn to the resolution of the beginning of the last eleven months of the year.

SECTION III.

Account of the Tables continued.

Resolution of the last eleven months of the year.

We have shewn at page 15, that the beginning of the Tamul year, when resolved into European Time, is an Index which indicates the limits between which the first day of every month, besides *Chaitram*, must fall, in its proper concurrent month; and that the monthly date sought never recedes more than two days from the same (in the particular cases of the month Maussi ♒ and Poongoni ♓), and never exceeds it for the remaining 10 months more than four days. On this data we proceed as follows:

Example I.

Let it be proposed to expound on what month and day of our Gregorian year 1745, *Ravi-vara*, 1st Paratasi ♍, A. Cm. 4847, happens to fall.

I.

We find by Table III, that the Tamul month Paratasi, concurs with our month September; and by the Rule at the foot of Table I, that the 1st Chaitram and year Cali yugam 4847 began on a Sucra-vara (Friday), which being expounded according to the Rule given in this Article, is found to fall on the 9th April Gregorian Style, and consequently that the 1st Paratasi of the said year cannot have fallen before the 9th, or after the 13th of September. Lastly, we have found that the Dominical Letter for 1745 was C, and for 1746 B, N. S.

II.

With these data referring to any Kalendars, it follows that *Ravi-vara*, the Sunday to be expounded, falls on the 12th September 1745 Gregorian Style.

The same, Julian Style.

But if we require the date Old Style, having found that the beginning of the same year fell on *Sucra-vara* (Friday) the 29th of March, and that the Dominical Letter was F, reasoning as before, it will be found that the same *Ravi-vara* falls on Sunday the 1st September O. S.

* * *

Intermediate days of any month how to be registered.

With respect to the intermediate days of any month, it is plain that we need only count as many units as there are days between the 1st of the month and the given date, and add the sum to the European date, and vice versa, subject to what has been said on the duration of the Hindu months, at Article 5, page 15.

Example II.

Thus it having been found that *Ravi-vara*, 1st Paratasi, A. Cm. 4847, fell on Sunday the 12th September 1745 N. S., if any other day, as *Mangala-vara*, 10th Paratasi, were proposed, there needs only to apply 9 days to the 12th of September, and we find that the proposed date falls on the 21st of the same month.

It is, however, to be remembered, that when any European date, whose concurrent may prove far advanced in the Tamul months, is to be expounded, as it is unknown of how many days the said month may be composed in the given year, there remains a doubt to which Hindu month the said date may belong, which to resolve, the beginning of the ensuing month must be expounded (vide Memoranda infra, page 30 and 31.)

When the European date falls near the end of the Hindu month, the beginning of the ensuing one is to be expounded and the dates established in *Ascendentia.*

Table VII, *page* 9.

Although the practice of counting by years of Christ was only introduced in Italy during the VIth century, and in the North of Europe towards the VIIIth, under Charlemagne ; and even then, that there were no less than eight different manners of counting the years of Incarnation (vide Art de Verifier les dates, page iv), yet Astronomers and Chronologists have found it expedient to establish an *ex post facto* Kalendar, which might serve as a common scale for measuring past and future ages, altho' such a scale were unknown in the times referred to. Thus European Astronomers have protracted the Julian Kalendar, for the purpose of extending their Sydereal Tables, up to the year 800 before Christ, because the ancient Chaldaic observations ascended to that epoch, having preferred that division of time to any other, on account of its being more simple, commodious and uniform. For the same reasons, I have been induced to extend the Tables of which Father Beschi was the original inventor, to the aforesaid, and higher epochs.

The only remark to be made on this Table is, that the two last columns give, viz. the second, the epochs for the Secular years from A. D. 0 to 2000, according to Beschi's method, and the third, the proper Roots for the same years, the only difference being, that the former are for one year later, than the latter, as has been hinted at page 17.—These elements were both given, although either one could have been sufficient for the purpose of preventing mistakes when departing from Beschi's system.

Table VIII, *page* 10 *and* 11 *of the Tables.*

This Table gives the *Epochs* and *Roots* of Secular years in ascending progress, from A. D. 0 to the Creation, as indicated in the respective columns.

The fourth column, 1st part, gives the absolute Root of the beginning of Chaitram and year for the first 10 years before Christ, i. e. from A. Cali yugam 3102 to 3112 ; and afterwards from 10 to 10 years, up to 3002, concurrent with Anno Ante Christum 100. The fourth and fifth columns of the second part of the same Table give, the former the Epochs, the latter the Roots for every century as far back as A. A. C. 1000, and subsequently from 1000 to 1000 years up to A. Ante Cali yugam 903-2, the epoch of the Creation.

Thus if the beginning of a year not given in the Table be required, take the Root of that nearest to it ; and complete the Rule by adding thereto for the odd years *taken out* of *Table I.*

EXAMPLE.

I.

Let the beginning of Chaitram and year 98, Ante Christum, be required, concurrent with A. Cm. 3004.

		D.	G.	V.	P.
Root for A. C. 90, Table VIII, part 1st, column 1st		(5)	44	22	30
Subtract 8 years from Table I.	—	(3)	4	10	0
Beginning of Chaitram and year	Tuesday	(2)	40	12	30

II.

Had we worked with the Epoch, Table VIII, part 2d, the operation would have been thus:

		D.	G.	V.	P.
Epoch A. D. 0, Table VIII.		(1)	16	46	15
Subtract for 90 years, Table I.		(1)	16	52	30
Subtract again for 9 years complete		(6)	59	53	45
Because by notation the years are *increasing* in *ascending*, Table I.	—	(4)	19	41	15
The same as before		(2)	40	12	30

TABLE IX, *page* 12.

Exhibits the Dominical Letter for every day in the year. It requires no explanation.

SECTION IV.

MEMORANDA to be referred to in expounding dates.

Note whether the given European date is likely to fall before or after 1st Chaitram.

1º In expounding any date of the month of March or April from European to Tamul time, it is necessary, before noting the concurrent year Cali yugam or Saca, to see whether it is likely to fall *before* or *after* the 1st of Chaitram, which begins about that time.

Thus suppose the 7th April 1745 N. S. had been propounded, the process indicated at page 18 would have been merely 1745+3102=4847 (1668 Saca) current.

But as we may see (Example 1st, Part II infra), that the said year began on the 9th April, it is plain that in this case, the current years Cali yugam and Saca, must be noted *one less*, and that the given 7th April falls on some of the latter days of the month Poongoni A. Cm. 4816, or Saca 1667.

When the given date falls before that which begins the century, take x—1 for the notation of the year.

2º When the given date falls before that which is indicated in Table V, part 3, as beginning the century, then as the beginnings of successive years proceed like the *Ayanansa* in *Consequentia* (*), it is manifest that the year Cali yugam or Saca, instead of being noted x+3102, must be taken (x—1) +3102.

(*) During the present Pada.

Thus if 3d April 1750 N. S. be proposed, since A. Cm. 4802 (1700—1) is shewn in Table V to have begun on the 8th April, it is manifest that the notation of the year must be (1750—1) +3102=4851; or 4851—3179=1672 Saca, and not 4852 Cm. and 1673 Saca.

But if the proposed date be 9th April 1798, observing in Table V that 4802 (1700) begins on the 8th, and 4902 on the 10th of that month, *there is a doubt* to which of the years 4900 or 4899 Cali yugam, the given one belongs; but the resolution of the beginning of 4900 (1798+3102) will at once resolve the question, and the year may be noted after the operation.

3. The notation of a date in *Antecedentia* (as in the preceding case) when it falls within *four* days from the nearest beginning of the month,—or in *Consequentia*, when it exceeds 28 days from the beginning of its own month, is also a matter of doubt, and must be resolved. In both cases this depends on the number of Kalendar days counted either in the preceding or in the current month. That is, if the proposed date happens to precede the 1st Chaitram (or any other month) by a few days, its notation in *Antecedentia* will depend on the number of Kalendar days counted in the preceding month *Poongoni* (or any other preceding month), which *Poongoni* varies from 30 to 31 days, not depending on the preceding year being a common, or a leap year, as is the case in the European Kalendar.

Notation of dates in antecedentia or consequentia, how to be determined.

Depends on the number of Kalendar days counted in the preceding or current month—not on a common or bissextile year.

In the same manner, if any date in *Paratasi* exceeding the 28th, be proposed, it will be a matter of doubt whether it does fall in that month, or in the following *Arpesi*, because that month may vary from 30 to 32 days.

In this uncertainty, the number of Kalendar days in the month where the proposed day seems to fall after addition or subtraction, must be calculated.

EXAMPLE.

Suppose we have found by the usual process that the 9th April 1798 fell on the last day of the Tamul month Poongoni ♓; is it to be registered in the Tamul Kalendar the 30th or 31st of that month?

RULE.

		D.	G.	V.	P.
The 1st Chaitram and year Cali yugam 4900 (1798) having been found to fall on the 10th April, whose Root is - - - -	Tuesday	(2)	7	42	30
Subtract therefrom the Root for Poongoni, Table III, part 2 -	—	(2)	20	21	1
Beginning of Poongoni 4899 Cm. - - - -		(6)	47	21	28

Various lengths of the Tamul months,—the manner of determining the same.

Saturday, which expounded with its proper Dominical Letter G, falls on the 10*th March*; therefore, in the present case, the *Kalendar* month Poongoni has 31 days; and the date concurrent with the 9th of April is to be registered 31st *Poongoni*. But if we want its notation as a *Civil* day, considering that the fractional part of the sum which determines the beginning of Poongoni, viz. 47g 21v 28p exceeds 30 guddias, the Civil beginning of that month is to be registered *one*

Notation of the day in the Kalendar as a Civil day.

day later, i. e. on the 11th March. But as the fractional part of the Root of 1st Chaitram 4900 (*7g 42v 30p*) is below 30g, both the Civil and Sydereal day coincided on the *10th* April, which makes no room for the Civil advance of the 1st *Poongoni*, and therefore the said Civil month will have counted only 30 days, and the proposed date, 9th April, must be registered the *30th* of that month.

The reduction of epochs to different geographical positions postponed.

4º We should now consider the *reduction of* the epochs so computed for the Meridian of Lanca, to some other Meridian; which involves a great variety of considerations.

With respect to the mere difference of Longitude, the Indian is the same as the European process. They make their mean epochs to occur sooner or later, as the place computed for lies East or West of Lanca. The difference of Longitude of the principal places in India in degrees, Indian time and yojanas, will be found in Table XXXIII, page 43 of the Tables, as they are given in some of their Ephemerides, and will suffice to transfer the above *mean* epochs, from the Rec'ha (Meridian) of Lanca to any other Meridian.

Rec'ha the Meridian of Lanca.

But the case is *quite* different, when the true epochs, counted in apparent time from the instant of Sun rising, are to be determined (as they are in the Tamul Solar Kalendar) for any particular place which has any geographical Latitude. For the resolution of this part of the problem, Hindu Astronomers have recourse to *Tropical Astronomy* and to *Gnomonics*, in which branch of the science they have shewn much ingenuity, and a respectable knowledge of Plane and Spherical Trigonometry. But the reader is not supposed sufficiently advanced in the knowledge of Hindu Astronomy, to enter now into such topics with any prospect of advantage. I shall, therefore, postpone what I have to say on this matter, to the time when we come to consider the theory and construction of the *Chandra Mana*, the Hindu Astronomical year, which is its proper province Meanwhile, I shall observe that, for mere chronological purposes, such as the resolution of dates, what has been said in the preceding Articles will be found perfectly sufficient.

PART II.

To convert European into Tamul time, referred to a given Meridian.

NOTHING can be more plain and simple than the Rule which elicits the weekly day marking the beginning of Chaitram and year, by means of the Tables: it remains the same and is equally expeditious for all possible cases near or remote, and may at pleasure be performed by addition or subtraction, as the computer may chuse to reckon from an antecedent or subsequent epoch. The result is equally certain, and as far as the day of the week is concerned it requires no Bija or P'hala (correction or equation), like most other Hindu problems. Thus the Rule given at the foot of Table I, teaches us every thing required on this score; for if we take the epoch either from A. D. 1700 or 1800, viz.

	Table I.		Table VII.
Epoch 1700 - -	(6) 2 11 15	Epoch 1800 -	(5) 54 16 15
	(1) 20 50 0	Table I, 50s	—(6) 56 2 30
	(5) 2 5 0		(5) 58 13 45
Weekly day, Friday,	(5) 25 6 15	—6	(0) 33 7 30
			(5) 25 6 15

we have equally Friday arising out of the Root (5) counted from Sunday.

It would have been therefore superfluous to multiply examples, were it not for the resolution of the monthly European date concurring with the feria according to our reckoning, which (considering the interruption which our Kalendars are subject to from the introduction of bissextile years, and the two Styles) renders that part of the problem somewhat complicated.

The following Examples have therefore been chosen, to exhibit every possible case where the notation of the Dominical Letter, on which every thing depends, may require caution or distinction in order not to be mistaken. The perpetual and consequently fastidious repetition of the process will, I trust, be forgiven, on considering that the subject is a new one, and that when engaged in such operations, a reference to preceding Examples by diverting the attention, is always irksome and discouraging.

Generally, when the feria is known, a glance at Table V (last column of each division) will always shew within the limits of *three days* for the Julian Kalendar, and *four days* for the Gregorian, on what monthly date the weekly day obtained by the foregoing Rule will fall. For if the Hindu year concurring with A. D. 1700, begins on the 28th, and 1800 on the 29th March

Old Style, then the Friday above elicited must fall between the 27th and 30th of the said month, and it accordingly concurs with the 29th. And if the same beginnings fall on the 8th and 10th April *New Style*, then the same Friday must concur between the 7th and 11th of that month, and so it falls on the 9th. When very remote epochs are considered this approximation will generally appear sufficient, but we are not therefore to neglect the means of attaining a greater degree of exactitude.

As whatever European date may be proposed to convert into Hindu time, is always clearly known to the computer by means of the particular designation it bears, a very slight attention to the notation of the date, to wit, whether it refers to before, or after the birth of our Saviour,—from the epoch of the Creation, or from that of the Hejira ; also whether it be according to the Old or New Style, will be sufficient to remove any cause of uncertainty.

Example I.

Let it be proposed to find the Tamul concurrent date to the 9th April 1745 Gregorian Style, under the Meridian of Lanca.

Caution.

Referring to Table V, part 2d, we find that in the Secular Christian year 1700, the Tamul year concurrent thereto began on the 8th April N. S., and in 1800 on the 10th of the same month, therefore the beginning of any year in the 18th century may fall from the 7th to the 11th April N. S. ; but it is doubtful whether the given date will fall in A. Cali yugam (1745+3102)=4847, or in 1744+3102=4846. We must therefore reserve the notation of the year until we know on what day of our April the Sydereal beginning of A. Cm. 4847 will fall. (*)

Rule.

	D.	G.	V.	P.
Root for 1700, Table I.	(6)	2	11	15
40 years, do.	(1)	20	50	0
4 do. complete	(5)	2	5	0
End of 4846, or beginning of	(5)	25	6	15

4847 to be counted from Sunday, i. e. *Friday*.

In order to find on which day of our April 1745 this Friday will fall, we are to proceed as follows :

Table V, part 2d, shews that the 18th century began on a Friday ; and Table VI, part 2d, that 45 odd years give 0 day to be added thereto, in order to have the day of the week on which the year 1745 began, which therefore remains *Friday*, and shews that the Dominical Letter was C.

(*) Vide Memorandum 1º page 30. In all the following Examples the years Cali yugam and Saca are noted in the proposition as *current* : but the year *complete* is always used in the resolution. For if 1745 be proposed, and 1744 be used in the computation, it is clear that we work for Cali yugam 4846 ending or 4847 commencing.

Now reverting to Table V, part 2d, column 3d, we find that the beginning of the Tamul year 4802 (concurrent with 1700) fell on the 8th of April; and as it has been observed that the beginning of the concurrent year cannot exceed that date by more than *three* days, referring to any perpetual Kalendar with the Letter C in the beginning of April, we find that the Friday elicited by the present Rule fell on the 9th April N. S. Hence we have the following

Table IX, p. 12.

ANSWER.

The 9th April A. D. 1745 N. S. is concurrent with the 1st Chaitram and year Cali yugam 4847 commencing, which shews the proper notation of the year.

N. B.—As the Gregorian Kalendar was only admitted in England in the year 1752, it may be necessary to resolve the question according to the Julian style, which is to be effected as follows:

The same according to the Julian Kalendar.

The Tamul Rule remaining as before, and the Root being *Friday* (5^{d}) 25^{g} 6^{v} 15^{p} a common year, we find by Table V, part 1st, that the Secular year 1700 O. S. began on a *Monday*, and for 45 odd years, Table VI, part 1st, gives *one* day to be added thereto, in order to have the weekly day beginning the year 1745 O. S. i. e. *Tuesday*, and consequently that the *Julian* Dominical Letter for that year is F.

Again, Table V, part 1st, column 5th, shews that the Tamul year Cali yugam 4802 concurrent with 1700, began on the 28th of March, and that of 4902 on the 29th of the same month; therefore 4847 must begin within the 27th and 30th, and entering the perpetual Kalendar with the Dominical Letter F about that time, we find that the Friday to be expounded falls on the 29th of March, &c.

EXAMPLE II.

Wanted the Tamul month and day corresponding to our 1st January 1813, Gregorian style, under the Meridian of Lanca.

As the proposed date falls considerably before the 1st of April, there can be no doubt but that we are to take (1813—1)+3102=4914 for the notation of the concurrent year Cali yugam (vide Memorandum 2, page 30) and that we are to work with 1812.

RULE.

		D.	G.	V.	P.
With 1800 refer to Table VII, you find Epoch		(5)	54	16	15
Root for 10 years, Table I		(5)	35	12	30
Do. for 1 year complete		(1)	15	31	15
Beginning of year and Chaitram 4914,	*Friday, Sucra-vara,*	(5)	45	0	0
		a leap year.			
To get now to the month of Tye ♑ (Tamul January), take out of Table III, part 3d, the Root for Margali ♐, complete		(2)	39	30	14
Beginning of Tye	Monday *Soma-vara.*	(1)	24	30	14

In order to find the monthly date of this *Soma-vara*, we must first determine that of the Friday on which the 1st Chaitram 4914, happens to fall.

Proceeding as formerly directed, we find by Table V that the 19th century began on a *Wednesday*, Gregorian Style: and Table VI, part 2d, shews that for 12 years 0 day is to be added thereto, in order to have the weekly day which begins the given year; therefore, A. D. 1812 also began on a *Wednesday*, and consequently the Dominical Letters (the year being bissextile) are ED; and lastly, as the date proposed falls on the beginning of the ensuing year, the Dominical Letter to be used is C when expounding the three last months of A. Cm. 4914 (1813.)

Now by Table V, part 2d, column 3d, it appears that on the Secular year 1800, the Tamul year began on the 10th April, and for 1900 on the 12th of the same month. Therefore, referring to any perpetual Kalendar with the Letter D, we find that Friday, 1st Chaitram 4914, falls on the 10th of April 1812.

Again, the Rule in the present Article has shewn, that the month *Tye* ♑ (Indian January), falls on a *Monday* (Soma-vara.)

But since the month Chaitram began on the 10th April, no other month in the same year (besides Maussi, which always begins one day sooner) can commence in its own concurrent month later than the 14th (vide page 8), and as we refer to the first days of our January 1813, the Dominical Letter to be used is no longer D, but C. Hence, referring to the perpetual Kalendar with that Letter in the beginning of January, we find that the proposed *Monday* falls on the 11th January 1813 N. S. the concurrent date to 1st Tye 4914.

But the date which is proposed is the 1st January; we have, therefore, an excess of 10 days, which will throw its concurrent Tamul date in the month of Margali ♐ (Indian December) and must be resolved in *Antecedentia*. (vide Mem. 3º page 31).

In order to have the correct date in Margali after subtraction of 10 days, we must determine how many Kalendar days in the given Tamul year, that month contains, for which purpose we have the following process.

		D.	G.	V.	P.
By Rule (present Article) we have the Root for 1st Tye ♑, A. Cm. 4914 -		(1)	21	30	11
Subtract Root for Margali, Table III, - - - -		(1)	20	53	1
Beginning of Margali, - - - -	Ravi-vara	(0)	3	37	10

for which using the Dominical Letter D (because Margali is concurrent with December 1812) we find *Sunday* 13th December. Hence - - - 31d in December.

— 13

18 rem. in Dec.

And as Tye began 11th January - - - - 11 in Jan.

Number of days in the month Margali - - - 29

From which subtract - - - - - 10 in excess

There remains 19

ANSWER.

The 1st of January 1813 falls on *Sucra-vara* (Friday), 19th Margali, A. Cm. 4914.

N. B.—It will be found by adding the Roots of the months Tye, Maussi, and Poongoni, Table III, part 2d, to that of the beginning of Tye, found in the present Article, that the ensuing year 4915 and Chaitram, falls on Sunday, 11th April 1813, which shews that the operation has been well performed (vide General Table of Solar years XIXth century, at the end).

EXAMPLE III.

In the year of Christ 800, Easter Sunday fell on the 19th April Julian Style, Alexandrian computation : wanted the Hindu date thereof.

As it appears from Table V, part 1st, that the Tamul year Cali yugam 3902 concurrent with A. D. 800, began on *(Wednesday)* Bhuda-vara, the 20*th March* O. S. and that the Dominical Letters were ED, no further calculation is required for the 1st Chaitram of the said year.

But the proposed date is the 19th April, which is 30 days more, therefore the date required should fall on the 31st Chaitram, provided that month contains that number of Kalendar days ; to ascertain which we have, as before, the following process.

		D.	G.	V.	P.
Epoch 800, Table VII, - - - - -		(0)	13	26	15
Subtract one year for the Root, Table I, (vide Part I, page 13), -		(1)	15	31	15
Beginning of Chaitram A. Cm. 3902 - - -	Friday	(5)	57	55	0
If we wish to verify the operation to the above last Root -	Friday	(5)	57	55	0
Add Root for the month Chaitram - - - -		(2)	55	32	1
	Monday	(1)	53	27	1

which Monday being expounded by means of the Dominical Letter D, about 20th April, (because the preceding month began 20th March) we find 1st Vyassei ♉ on the said 20th April,—therefore the month of *Chaitram* counts 31 days, and the Tamul date *Ravi-vara*, 31st Chaitram, answering to Sunday, 19th April, A. D. 800, has been well expounded.

EXAMPLE IV.

A Missionary wants to determine on what Kalendar Tamul year, month and day, Christmas day A. D. 1812 Gregorian style, happens to fall; and wishes to note the current year from the epoch *Saca*, that of the birth of Salivahana.

RULE.

The year Cali yugam current with A. D. 1812 (1812+3102) is 4914 current ; but from what has been said at page 17, the concurrent year Saca is (4914—3179) 1735.

To proceed, using as before 1812—1.

		D.	G.	V.	P.
Epoch for 1800, Table VII,		(5)	54	16	15
Add Root for 10 years, Table I,		(5)	35	12	30
Do. for 1 year complete, do.		(1)	15	31	15
Beginning of Chaitram and year Saca 1735	Friday	(5)	45	0	0
		a leap year.			
And to get to Margali, (Indian December) add Root for Cartiga complete, Table III, part 3d,		(1)	18	37	1
Beginning of Margali	*Sunday*	(0)	3	37	1

We are now to expound these, Friday, 1st Chaitram, and Sunday, 1st Margali, for which Table V, part 2d, shews that the 19th century begins on a *Wednesday*, and Table VI, part 2d, that for 12 odd years 0 is to be added to the said Wednesday, to have the day of the week on which A. D. 1812 begins; which therefore also occurs on a *Wednesday*, and gives the Dominical Letters *ED*, that year being *bissextile.*

Now it appears by Table V, part 2d, column 3d, (page 6,) that the year Cali yugam 4902 (1800) begins on the 10th April N. S. and 5002 on the 12th, therefore the proposed year must fall about the 9th and 13th, which are its limits; and for reasons already referred to, that the 1st of Margali cannot occur earlier in December than the 9th, or later than the 14th.

With these data refer to the perpetual Kalendar with the Dominical Letter D, and you have

Friday, 1st Chaitram, and year Saca 1745 - 10th April,
Sunday, 1st Margali, - - do. 13th December.

But the proposed date is 25th December, which is 12 days later, therefore Christmas day A. D. 1812, falls on Sucra-vara, 13th Margali of the year Saca 1735.

Example V.

The epoch of Hejira, or flight of Mahomed, occurred on the 16th July A. D. 022 Julian Style: wanted its concurrent Hindu date.

Caution.

As the proposed date falls considerably beyond the beginning of April, there can be no question as to the notation of the years Cali yugam and Saca, which are, viz. Cali yug (622+3102) 3724 and Saca (3724—3179) 545, both current.

Rule.

		D.	G.	V.	P.
Epoch for the Secular year 600, Table VII,		(0)	29	16	15
Root for 20 years, Table I,		(4)	10	25	0
Do. for 1 year complete,		(1)	15	31	15
Sydereal beginning of Chaitram and year Cm. 3724	Friday,	(5)	55	12	30
		a leap year.			

	D.	G.	V.	P.
And to get to the Indian month Audi (ஆ) June, add Root of Auni II complete, Table III, part 3d, - - -	(2)	56	22	0
Beginning of Audi A. Cm. 3724 - - - Monday,	(1)	51	34	30

Now to expound the Christian date of the 1st Chaitram and 1st Audi, we find by Table V, part 1st, that the Secular year 600 Julian Style, began on a Friday, and by Table VI, that 22 odd years give 0 day to add thereto, in order to obtain the feria beginning A. D. 622, which therefore also begins on a *Friday*. Hence the Dominical Letter is C, Julian Style.

But Table V, part 1st, shews that the year Cali yugam 3702 (600) began on the 19th March, and 3802 on the 20th, therefore 1st Chaitram 3724, must fall about either of those days (page 15).

Referring therefore to the perpetual Kalendar with the Letter C, near the 19th March, we find Friday, 19th March, for the beginning required.

In the same manner, since the beginning of Audi cannot fall before the 18th, nor after the 23d of June (vide Example II and IV), the same process shews that Monday, 1st Audi, falls on the 21st June; and therefore, as the proposed date is the 16th July, that it will fall 25 days later, i. e. on the 26th of Audi.

ANSWER.

The 16th July A. D. 622 falls on *Sucra-vara*, the 26th Audi, of the 3724th year of the Cali yug, and 545 Saca.

NOTE.—Too much attention cannot be paid when converting dates proposed in the *Julian style* into the corresponding date of the Tamul Solar year. For although there is no danger of mistaking the European month which corresponds with the 1st Chaitram of the year sought, its being always clearly indicated by Table V, yet if the proposed date be advanced in the year, as is the case in this Example, the eye, on taking out the European month, which let it be that corresponding to Audi, out of Table III, may hit on the 2d Section of that Table, where Audi corresponds to July N. S., instead of the 1st, where it answers to *June* Old Style.

Thus in the present Example, if through mistake the month *Audi* were taken to answer to our *July* (as it does in the Gregorian), instead of *June*, which is the corresponding month of the Julian Style, then the 16th July would be made to fall on the 29th *Auni* instead of the 26th Audi, which is its correct date.

EXAMPLE VI.

An European lets a house on lease to a Native, for a certain period of time, which is to expire on the 11th April 1839; the Native wants to know on what year, month and day of his own reckoning, his lease is to expire.

OBSERVATION.

As the year Cm. 5002 (1900-1) begins on the 12th April (Table V), there can be no doubt about the notation of the year, which must be (1838+3102) 4940 Cali yugam, or (4940—3179) 1761 Saca, both current.

RULE.

		D.	G.	V.	P.
Epoch for 1800, Table VII,		(5)	54	16	15
Root for 30 years, Table I,		(2)	45	37	30
Do. for 7 years complete, do.		(1)	48	38	45
Beginning of Chaitram and year 1761 Saca or Cali yug 4940	*Wednesday*	(3)	28	32	30

a common year.

To expound which, we find by Table V, part 2, that the 19th century begins on a *Wednesday;* and by Table VI, for 38 years, that 5 days are to be added to the same for the feria beginning A. D. 1838, i. e. *Monday;* therefore the Dominical Letter for that year is G, Gregorian Style.

Now the Hindu year 4902 concurrent with 1800, begins on the 10th April, and 5002 on the 12th, therefore the commencement of 4940 must fall about these limits.

Referring, therefore, to the Kalendar with the Dominical Letter G, near that date, we find that Wednesday, 1st Chaitram, falls on the 11th April, which is precisely the given date.

ANSWER.

The Native is to surrender the house on Bhuda-vara, 1st Chaitram, A. Cali yug 4940, and Saca 1761.

EXAMPLE VII.

The Chronologists reckon that our Saviour was born on the 5th year before Anno 0 Dyonisian æra, from which circumstance we account our time 5 years too late. What is the concurrent Hindu date with Christmas night of the said year?

CAUTION.

1º We are to notice when taking the Roots out of Table VIII for the odd years before Christ, that as the centuries are increasing in notation whilst ascending, *one more* odd year is to be used for the end of the year expired, instead of one *less*. Thus had the proposed year been A. D. 5 current, we would have used 4 complete; but having to expound A. A. C. 5, we are to use 6.

2º The given year is a *common one.*

3º The proposed month falls considerably after April; and the notation for the year will therefore be (3102—6) 3096 complete, and 3097 current.

RULE.

Table V, part 3d, shews that the secular year Ante Christian Æra 100, began on a *Friday,* and its Dominical Letters are CB; the same Table shews also, that the Hindu year Cali yugam 3002 concurrent therewith, began on the 13th of March Julian Style.

With the year Cali yugam 3096 *complete*, referring to Table VII, we find at once (not the epoch) but the Root for the proposed year.

	D.	G.	V.	P.
Sunday	(0)	43	38	45
And to get to the Indian month of December, referred to the Old or Julian Style, take the Root for Margali, Table III, - -	(2)	39	30	11
1st Tye ♑ to be counted from Sunday, i. e. *Wednesday* -	(3)	23	8	56

To expound which, we have noticed that the beginning of A. A. C. 100 began on a *Friday ;* and Table VI, part 1st (the year being a common one) for 95 odd years gives 0 to be added to the same for the feria beginning A. A. C. 5, which therefore also commences on a Friday, and the Dominical Letter is C.

Again Table V, part 3d, shews that the Hindu Solar year 3002, concurrent with A. A. C. 100-1, began on the 13th March, and 3102 on the 14th, therefore 3097 must have begun near either of these monthly dates. Referring therefore, to the Kalendar with the Dominical Letter C about that time, we find that Sunday, 1st Chaitram and year, fell on the 14th of March.

And as this is an Index which shews that the other months cannot have begun earlier than the 12th, or later than the 17th, in their respective months (vide Example II and IV), the same process will shew that *Wednesday*, 1st Tye, fell on the 15th of December. We want therefore, 10 days from the proposed date (25th December), which added to 1st Tye, the sum gives *Saturday* the 11th of the said month.

ANSWER.

The 25th December A. A. C. (the day on which our Saviour was born) answers to Sani-vara, the 11th Tye of the 3097th year of the Cali yug current.

EXAMPLE VIII.

There was a total Eclipse of the Moon on the 15th May 1631 Gregorian Style. What day was reckoned in the Hindu Kalendar when this Eclipse occurred ?

REMARK.

Here we are to distinguish between computing the time of an Eclipse, which is to be effected by the resolution of time on principles totally different from those which regulate the *Madhyama Saura Mana*, and expounding the day which was reckoned in any Kalendar, (let it be ever so erroneous) when that event occurred. An Eclipse which was *observed* on any particular day cannot be controlled by any system of Astronomy ; and it's prediction, when determined on legitimate principles, can only fail by a very small quantity : it may therefore, be classed with actual observation. The present question is, therefore, only one of Chronology, and not of

Astronomy ; for it being known that the Eclipse occurred on a *Thursday*, all we have to do is, to determine what date this Thursday did indicate in the Tamul Kalendar, to resolve it.

This being understood, we shall proceed as usual.

CAUTION.

1° As the Secular year 1600 Gregorian Style, was a *Bissextile* one, we are to use part 1st of Table VI for the number of days to be added to the weekly day beginning the century, to have that which commences the given year (or any other year of the same century).

2° The proposed date falling in *May*, leaves no doubt respecting the notation of the year, which should be (1631+3102) 4733 Cali yugam and (4733—3179) 1554 Saca, both current: then with 1631—1.

RULE.

		D.	G.	V.	P.
Epoch for A. D. 1600, Table VII, - - -		(6)	10	1	15
Root for 30 years, Table I, - - -		(2)	45	37	30
Beginning of Chaitram and year 1554 Saca - -	Monday	(1)	55	38	45
			a leap year.		

And to get to the month Vyassei ♉ (Indian May), add the Root for Chaitram,

Table III, part 3d - - - - - -		(2)	55	32	1
Beginning of Vyassei - - - - - - -	Thursday	(4)	51	10	46

In order to expound these, Monday, 1st Chaitram, and *Thursday*, 1st Vyassei, we find by Table V, part 2d, that the Secular year 1600 began on a *Saturday* ; and for the number of days to be added thereto, in order to get the feria beginning A. D. 1631, we have by Table VI, *part* I, (vide Caution) for 31 years, 4. Therefore, the weekly day required was *Wednesday*, and the Dominical Letter for that year E.

Now by Table V, part 2d, column 3d, it appears that the Hindu year Cali yugam 4702 (1600) began on the 6th April, and 4802 on the 8th; therefore, referring to the Kalendar about that time, we find that *Monday*, 1st Chaitram, fell on the 7th of April ; and as the other months cannot begin earlier than the 4th or later than the 10th of their respective concurrent European months (Example II and IV), we also find that Thursday, 1st Vyassei, fell on the 8th of May.

But the Eclipse occurred on *Thursday* the 15th of May, which is 7 days later, therefore the notation of the Hindu Sydereal time is *Guru-vara*, 8th *Vyassei*, A. Cm. 4733 and 1554 *Saca*, under the Meridian of and at Lanca.

OBSERVATION.

With respect to the *Civil* day registered in the Kalendar, we are to observe that as the fractional part of the Root (51^g 10^v 46^p) of the beginning of Vyassei, exceeds 30 guddias, the Tamul month of that name must be accounted to begin, not on *Thursday*, but on *Friday* the 9th May, Civil time, which advances the notation of every day in that month by *one* day. Therefore, on consulting a Kalendar which gives *only the Civil day*, should we want the Sydereal day on which the Eclipse really occurred, we are to subtract *one* day, and suppose a fraction of at least 30 guddias reckoned from Sun rise, because the 9th Viassei so registered, is only the 8th with a fraction, as has been said.

But the Hindu Patras generally predict the Eclipses for the time from *true* Sun rise, in separate articles, and independently of the Civil day registered in the columns of the Kalendar.

EXAMPLE IX.

There will be an Eclipse of the Sun visible in the Eastern parts of Asia, on the 11th January 1899, at 11h P. M. referred to the Meridian of Paris.—On what year, month and day, according to the Tamul Style, is it to be expected under the Meridian of Lanca? to be expressed in Solar Time (vide remark, preceding Example, page 41.)

CAUTION.

The date falling in January, the notation of the Tamul year must be (1899—1) 1898+3102 =5000 Cali yugam, or (5000—3179) 1821 Saca, both current. (Vide Memorandum 2º page 30), and the Rule must be worked with A. D. 1898—1.

RULE.

		D.	G.	V.	P.
Epoch for 1800, Table VII,		(5)	54	16	15
Root for 90 years, Table 1,		(1)	16	52	30
Do. for 7 years complete,		(1)	48	38	45
Beginning of Chaitram and year A. Cal. 5000	Monday,	(1)	59	47	30

To expound the monthly date of which, we find by Table V, that the 19th century begins on a *Wednesday*, Gregorian Style; and Table VI, part 2d, for 98 years gives 3 days to be added to the said *Wednesday*, to have the feria beginning the year A. D. 1898. The Dominical Letter is therefore B, and for 1899 A.

Now to expound the Hindu date, we find by Table V, part 2d, column 3d, that the year Cali yug 4902 (1800) began on the 10th April, and 5002 on the 12th, therefore 5000 must have fallen near those limits, for which reason refer to Kalendar at the Dominical Letter B about that time, and you find *Monday* the 11th April, to be the required date.

But the predicted Eclipse falls on the 11th January of the *succeeding* year, which to deduce

		D.	G.	V.	P.
To the Root of 1st Chaitram above found		(1)	59	47	30
Add Collective Root for Margali ♐, Table III, part 3d,		(2)	39	35	11
You have beginning of Tye ♑, A. Cm. 5000	Thursday,	(4)	39	19	41

To expound this Thursday, we are to remember that as the 1st Chaitram of this Hindu year fell on the 11th April, none of the other months of the year can begin later than the 15th of its own concurrent month (vide Example II, page 35, and IV, page 37). Therefore referring to the Kalendar with the Dominical Letter A (because *Tye* falls in January 1899) about that time, you find that 1st Tye falls on the 12th January of that year.

But the proposed date is the 11th January, therefore the Eclipse will occur on the last day of Margali (the preceding month), which may count 29 or 30 days.

		D.	G.	V.	P.
For the resolution of this case, observing that 1st Tye fell on the 12th January, whose Root was		(1)	39	17	41
Subtract Root for Margali, Table III, part 2d,	—	(1)	20	16	1
There remains beginning of Margali	Wednesday	(3)	19	1	40

which expounding with the Dominical Letter B (because we return to December 1898), about the 12th, we find this Wednesday falling on the 14th December. Hence from 31 days in

December	31
Subtract	14
There remain	17 in Dec.
Add 12 days the date of 1st Tye in January	12
Number of days in Margali A. Cm. 5000	29 days.

Hence the 11th January must be noted Bhuda-vara (Wednesday), the 29th of Margali.

But the hour of the Eclipse referred to the Meridian of Paris was 11^h P. M. which to reduce to that of Lanca, we have

		H.	'	"	
Hour at Paris		11	0	0	P. M.
And to count from the preceding midnight		12	0	0	
		23	0	0	from midnight
Reduce to Longitude of Lanca from Paris, page 9,	+	4	54	12	E
In European Time	1°	3	54	12	from midnight
	D.	G.	V.	P.	
Which converted into Hindu Time gives, by Table IV,	1	9	45	30	Do.
And to count from Sun rsie Sub.		15	0	0	
There remains to be counted at Lanca	0	54	45	30	from Sun rise.

ANSWER.

The predicted Eclipse of the 11th January 1899, which is to occur at 11^h P. M. Meridian of Paris, was to be expected at Lanca, on *Bhuda-vara*, the 29th Margali, A. Cm. 5000 or Saca 1821, at 54 guddias, 45 viguddias, 30 paras after Sun rise or mean Solar time.

OBSERVATION.

As the fractional part of the Root for the beginning of Margali (19^g 1^v 40^p as above) falls short of 30 guddias, the Civil and Sydereal day for the whole of that month will coincide, so thut the notation remains the same.

It may further be observed, that retrenching the $51^{g}\ 45^{v}\ 40^{p}$ from the ensuing Sun rise, the Eclipse will occur at Lanca on the 1st Tye, $5^{g}\ 14^{v}\ 30^{p}$ *before Sun rise*, so that it will not be visible at that place.

EXAMPLE X. (*)

The most ancient Eclipse which has been transmitted to us from the Babylonians, occurred on the 19th March 720 *before Christ*, at $6^h\ 48'$ P. M. reduced to the Meridian of Paris.—Wanted the concurrent Hindu year, month and day, under the Meridian and Latitude of Lanca. (Vide Remark, Example VIII, p. 41.)

CAUTION.

The year 720 being divisible by 4 without a remainder, is a bissextile one, and therefore we are to use the 1st part of Table VI.

The proposed date being 19th March, and Table V, part 3d, shewing that the year Cali yug 3301 (700 A. C.) began on the 7th of that month, and 3404 (600 A. C.) on the 8th, there can be no doubt that the notation of the year must be (3102—720) 2382 Cali yug.

RULE.

	D.	G.	V.	P.
Root for the beginning of the year 700 before Christ, Table VIII, part 2d,	(0)	56	40	0
And for 20 years, Table I, - - - - sub. —	(4)	10	25	0
Beginning of Chaitram and year Cali yug 2382 current, - Wednesday	(3)	46	15	0

To expound which, we find by Table V, part 3d, that the Secular European year 700 began on a *Thursday;* and Table VI, part 1st, (the year being bissextile) for 20 years gives 4 to be *subtracted* from Thursday, i. e. *Sunday*, for the weekly day which begins A. A. C. 720, and consequently its Dominical Letters AG.

Again, by Table V, part 3d, column 6th, we find that the Hindu Solar year concurrent with A. A. C. 700, began on the 7th March, therefore referring to the Kalendar with the Letter G about that time, we find that Wednesday, 1st Chaitram, and year Cali yugam 2382, fell on the 7th March 720 A. C.

But the date proposed is the 19th of March current, or 18th complete; therefore adding 11 days to the 1st, we have *Ravi-vara* (Sunday), the 12th of Chaitram.

Now the Eclipse occurred at $6^h\ 48'$ P. M. Meridian of Paris, which to reduce to that of Lanca, we proceed as before.

(*) This Example refers to another given in the Note for equating the Ayanansa to the European Tables, given at the end of the volume.

		H.	′	″	
Time of Eclipse at Paris - - - -		6	48	0	from Noon.
To reckon from preceding Midnight - -	+	12	0	0	
		18	48	0	from Midnight.
Add Longitude in time from Paris to Lanca -	+	4	54	12	
Time in European hours, m. & s. - - -		23	42	12	Do.
		G.	V.	P.	
which converted into guddias, viguddias and paras, by means of Table IV, give - - - -		59	15	30	Do.
And to reckon from Sun rise at Lanca - -	—	15	0	0	
There remains time of Eclipse - - - Solar time.		44	15	30	from mean Sun rise,

ANSWER.

The Hindu time concurrent to that of the Eclipse which occurred on Monday the 19th March, A. A. C. 720, at 6^{h} 48′ P. M. Paris time, is 12th Chaitram, A. Cali yugam 2382, on Ravi-vara, at 44^{g} 15^{v} 30^{p} after Sun rise, Solar time, at Lanca.

PART III.

We shall now proceed to give some Examples of the converse of the proposition, which differs only in the manner of stating the question, the same Rule applying to both cases.

Example I.

A Native applies to a Collector to farm certain lands, and wants a Potah which is to bear date the 1st Chaitram, 1748 Saca. What is the concurrent date with that epoch, according to the European Kalendar?

Notation.

Saca 1748+3179=1927 Cali yugam,

and 4927—3102=A. D. 1825, therefore 1824 is to be used in the computation.

Rule.

To find the beginning of Chaitram and year Cali yugam 4927, proceed with 1825, as before, viz.

		D.	G.	V.	P.
Epoch for 1800, Table VII,		(5)	54	16	15
Root for 20 years, Table I,		(4)	10	25	0
Do, for 4 years complete, Do.		(5)	2	5	0
Beginning of Chaitram and year 1748 Saca	Monday	(1)	6	46	15

a common year.

To expound the date of this Monday, we find by Table V, part 2d, that the Secular year Cali yugam (4902) 1800, begins on a *Wednesday*, Gregorian Style; and 25 odd years, by Table VI, part 2d, gives *three* days to be added thereto, to have the weekly day beginning the year 1825; i. e. *Saturday*, and therefore the Dominical Letter for that year is B.

Now Table V, part 2d, column 3d, shews that the year Cali yugam 4902 (1800) began on our 10th April N. S. and 5002 (1900) on the 12th, therefore the commencement of 4927 cannot fall later than the 13th.

Referring, therefore, to the Kalendar at the Dominical Letter B about that time, we find that the *Monday* on which the concurrent Tamul year will begin, falls on the 11th of April; we have, therefore, the following

Answer.

The Potah bearing date 1st Chaitram, 1748 Saca, is to run from 11th April 1825.

Example II.

A Merasi was granted to the original proprietor on the 15th Margali (♐), A. 623 Saca, concurrent with A. Cali yugam 3802. Wanted the European date thereof.

NOTATION.

3802—3102=A. D. 700, and 699 to be used in the computation.

CAUTION.

1º Finding that the European concurrent date 700 falls considerably before the year A. D. 1582, this proposition must be expounded according to the Julian Style: therefore, part 1st of Tables V and VI, are to be used.

2º The proposed year, beginning the century, the Root for 1 year (1^d) 15^g 31^v 15^p must be subtracted from the epoch given in Table VII.

3º Margali being concurrent with the time about our December, the proposed date being 15th of the Hindu month, may possibly fall in our January 701.

RULE.

		D.	G.	V.	P.
From Root for Epoch A. D. 700, Table VII,		(0)	21	21	15
Subtract Root for 1 year, Table I,	—	(1)	15	31	15
Sydereal beginning A. Cm. 3802	Saturday	(6)	5	50	0
		a common year.			

And to get to the Hindu month Margali (♐), add the Root for Cartiga complete,

Table III, part 3d,		(1)	18	37	10
Beginning of Margali 3802,	*Sunday*	(0)	24	27	10

Now to expound the day on which these, *Saturday*, 1st Chaitram, and Sunday, 1st Margali, occur according to the European Kalendar, we find by Table V, part 1st, that the Secular year 700 began on a *Thursday*, and that the Tamul year concurrent therewith, began on the 20th March; therefore no further operation is required for this part of the Rule, the Dominical Letters DC being also given.

And for *Sunday*, 1st Margali, as it cannot fall earlier than the 18th or later than the 24th of November, referring to the Kalendar at the Dominical Letter C, we have *Sunday*, 21st of November.

But the proposed date is the 15th Margali, therefore adding 15 days to 21st November, we have Monday, 6th December.

ANSWER.

The Merasi being dated 15th *Margali*, Anno 623 *Saca*, was granted on the 6th December A. D. 700 Julian Style.

EXAMPLE III.

A Judge is moved to grant probate of a will, which bears date 20th Paratasi (♍,) A. 1577 Saca.—To what Christian year and date, does this will refer? N. S.

NOTATION.

1577+3179=4756 Cali yug, and 4756—3102=A. D. 1654; and 1653 is to be used.

CAUTION.

The Secular year 1600 is a bissextile one, therefore we are to use part 1st, Table VI, for the Dominical Letter.

RULE.

		D.	G.	V.	P.
Epoch A. D. 1600, Table VII, part 2d, - - - -		(6)	10	6	15
Root for 50 years, Table I, - - - - - -		(6)	56	2	30
Do. for 3 years complete, Do. - - - - -		(3)	46	33	45
Beginning of Chaitram and year 1577 Saca - -	Wednesday	(2)	52	42	30
	Bhuda-vara, a leap year.				
And to get to Paratasi, take the Root for Aurani (♌) complete, Table III, part 3d,		(2)	26	44	6
Beginning of Paratasi - - -	Friday	(5)	19	26	36
	Sucra-vara.				

To expound these, Wednesday, 1st Chaitram, and Friday, 1st Paratasi, we have by Table V, part 2d, the Secular year 1600 (a leap year) beginning on a *Saturday*; and Table VI, *part 1st*, for the number of days to be added thereto, to obtain the weekly day which begins A. D. 1654, gives for 54 odd years 5, to be added to Saturday, i. e. *Thursday*; and therefore the Dominical Letter is D.

Now by Table V, part 2d, the year Cali yugam 4702 (1600) begins on the 6th April; and 4802 on the 8th; therefore 4756 must fall near those limits, and referring to the Kalendar at the Dominical Letter D about that time, we find *Tuesday*, the beginning of Chaitram and year, 7th April. And as any other month in the same year cannot begin sooner in its concurrent month than the 5th and later than the 10th, we also find in the Kalendar at the Letter D, that *Friday*, 1st Paratasi, fell on the 9th September.

But the date of the will is 20th Paratasi, therefore adding 19 days to the 9th September, we have 28, and therefore

ANSWER.

The will dated 20th Paratasi 1577 Saca, has for concurrent European date 28th September 1654 Gregorian Style.

EXAMPLE IV.

History records that Seragee, the founder of the Marattah empire, died at Rairee, on Soma-vara, the 9th Chaitram, A. 1603 Saca. What is the concurrent date *Julian Style?*

NOTATION.

1603+3179=4782, and 4782—3102=1680 A. D.; and 1679 is to be used.

CAUTION.

As the date is to be expounded in Julian Style, we need pay no particular attention to the Secular year 1600, because all such years are bissextiles in the Julian Kalendar.

Rule.

	D.	G.	V.	P.
Epoch for 1600, Table VII, - - - -	(6)	10	6	15
Root for 70 years, Table I, - - - -	(4)	6	27	30
Do. for 9 years complete, Do. - - - -	(1)	19	11	15
Beginning of Chaitram and year 1603 Saca - -	(0)	36	15	0

To expound which, Table V, part 1st, shews that the 17th century began on a *Tuesday* Julian Style, and Table VI, part 1st, that for 80 odd years, 2 days are to be added thereto, in order to have the weekly day beginning the year 1680, i. e. *Thursday;* and consequently, that the Dominical Letters for that year are DC.

Now by Table V, part 1st, column 5th, the year Cali yugam 4702, concurrent with our Secular year 1600, began on the 27th March O. S., therefore 4782 cannot begin later than the 28th. Refer therefore, to the Kalendar at the Dominical Letter C about that time, and you will find the proposed Ravi-vara (Sunday), 1st Chaitram, to fall on the 28th of March.

But the date proposed is the 9th Chaitram, i. e. 8 days later; adding therefore 8 to 28th of March, we have the following

Answer.

Sevagee, having died on the 9th Chaitram, A. 1603 Saca, the date of this event is to be recorded as having occurred on Monday, the 5th April 1680.

⁂

NOTE.

On the Solar year used in the Southern Provinces of India and Cycle of 90 years, called Graha-parivrithi, the duration of the year being 365^{d} 6^{h} 12′ 36″ *European time, and* 365^{d} 15^{g} 31^{v} 30^{p} *Indian time.* (*)

NOT having been able to procure a copy of the *Vakya carana* (a treatise on Astronomy), in which I was told the theory of the Cycle of 90 years is explained, I have little to say on the principles of that particular division of time. I was indeed informed by the *Jyautish Sastras* of Madras, that it consisted of the sum of *one* Revolution of the Sun, 15 of Mars, 22 of Mercury, 11 of Jupiter, 5 of Venus, and 29 of Saturn: but probably, for want of the elements used by *Vararoochy* (the supposed author of the *Vakya carana*), I never could make the collective time due to these, amount to 32873^{d} 17^{g} 15^{v} which is the duration of 90 years of 365^{d} 15^{g} 31^{v} 30^{p} (†). But, be this as it may, there can be no doubt on the construction of the Kalendar, as it is here explained. It was analyzed by Father Beschi (from one of whose manuscripts I extracted in part the substance of the present Note) during his residence of above forty years in Madura, where he was in charge of the Portuguese mission in that and adjacent provinces.

The Southern inhabitants of the Peninsula of India use a Cycle of 90 Solar years, which is little known in the Carnatic: their Astronomers call themselves *Sittandij*, or *of the South*, in contradistinction of their Northern neighbours, whom they call the *Vachij*, not because that word signifies that opposite point of the compass, but because they use the *Vakiam* process in their computations, of which an account will be found in the second Memoir of this collection.

	D.	H.	′	″		D.	H.	′	″
(*) The European Sydereal year is	365	6	9	10	Anomalis	365	6	15	24
The Indian	365	6	12	30		365	6	15	0
Difference of the Indian	+		3	20		—			24

The European Tropical year being 365d. 5h 48′ 45″.

Vachij	D	H.	′	″		D	H.	′	″
Aria Siddhanta, Sydereal year	365	6	12	30	Vakya carana	365	6	12	36
European Tropical	365	5	48	45		365	5	48	45
Difference of the Indian		+	23	45			+	23	51

(†) Having computed the above mentioned number of Revolutions of the Sun and five Planets by the elements at my disposition, I found the time answering thereto equal to 32885d. 7g. 1v. giving a difference in excess of 11d. 59g. 46v.

The duration of the Solar year (which is Sydereal) they divide and express in the following manner:

$365^d\ 15^g\ 31^v\ 30^p = 52$ weeks $+ 1^d\ 15^g\ 31^v\ 30^p = 1^d\ 15\frac{1}{2}^g + 1\frac{1}{2}^v$. Then multiplying the first member $1^d\ 15\frac{1}{2}^g$ by 2, they have an *equation*, for two years, of $2^d\ 31^g$: which quantity they divide again into two unequal parts, viz. $1^d\ 16^g$, and $1^d\ 15^g$ (independently of the second member $1\frac{1}{2}^v$, of which more hereafter.)

The first equation, viz. $1^d\ 16^g$ they add to the *odd* years of the Cycle of 90, and the second $1^d\ 15^g$ to the *even* ones, beginning with the first year, with the exception of the 40th and 80th year, to which, though *even*, they add the first equation $1^d\ 16^g$.

With regard to the odd viguddia and half of the second term of the original equation, it is to be considered that in 40 years, this quantity amounts to *one* guddia (or Tamul hour), which they add to the 40th year, making its duration $365^d\ 16^g\ 31^v\ 15^p$. By this contrivance the beginning of the years of the *Sittandij* agrees very nearly with that of the *Vachij*.

Epoch A. A. C. 24, Cali yug 3078. Precept for finding the Cycles and years expired of the Grahaparivrithi at any given epoch.

The epoch to which the Cycle of 90 years refers, is when 3078 years of the Cali yug had expired; answering to A. Ante Christum 24: so that if the number of Cycles and years expired since the epoch be required, "subtract 3078 from the years expired of the Cali yug, divide the "remainder by 90, and the *quotient* gives the number of Cycles, and the *remainder*, the "number of years expired sought."

EXAMPLE.

Let the year of the Cali yug 4846 complete, be proposed. Wanted the elapsed Cycles and years of the Parivrithi.

Rule.

```
          Say A. C. 4846
                  — 3078
                    ----
                  90)1768(19
                     90
                     ---
                     868
                     810
                     ---
Remainder   .   .     58
```

which shews that on the year sought there were 19 Cycles and 58 years of the æra expired; and therefore, that the current ones were the 20th Cycle and 59th year.

We may operate on the same principle if the Christian year be proposed, by reversing the process.

EXAMPLE II.

Let A. D. 1745 (Cali yug 4846 complete) be proposed; to find the Cycle and year of the Grahaparivrithi.

1°
1745
— 1
1744
+ 24
1768. The same result as in the preceding Example.

2°
90)1768(19
90
868
810
58

On the construction of the year, and of Table II.

Construction of the year and of Table II.

The Ahargana of the *Sittandij* on the beginning of the Solar year 3102, which occurred (according to their account) on Saturday the 13th March A. D. 1 is - - - - - -

Now if to that sum you add for 1701 *of their own years*, -

	D.	G.	V.	P.
	1132664	54	50	45
	621305	9	9	15
7)1753970(		4	0	0

Remainder 1 from Friday
Sonta dina *Saturday.*
(*)

The Ahargana for the Solar year, which ended on Saturday 29th March O. S. will be 1753370d 4g, and in order to count from *Sunday*, instead of *Friday*, the Root of the same must be expressed by (6d) 4g, as was explained at pages 9 and 10; and as appears at the head of Table II as the epoch for A. D. 1700, which quantity they call Atchù.

Atchu, an epoch to which computations are referred.

For finding the circumstances of any proposed year the commencement of which has been determined, the Rule is exactly the same as that which has been explained in the Memoir on the Tamul year, the only difference being in the duration of the months, which is very trifling. It is given here merely because it represents those of the *Surriah Siddhanta*, within a *para* of time on the whole year.

Rule for the months.

		Names Surriah Siddhanta.	Names Tamuls.	Sydereal duration of each month.				Separate Roots.				Collective Roots.			
				O.	G.	V.	P.	O.	G.	V.	P.	O.	G.	V.	P.
♈	1	Mésha masa	Chaitram	30	55	32	3	(2)	55	32	3	(2)	55	32	3
♉	2	Vrísha masa	Viassei	31	24	12	4	(3)	24	12	4	(6)	19	44	7
♊	3	Mid'huna masa	Auni	31	36	38	4	(3)	36	38	4	(2)	56	22	11
♋	4	Carcáta masa	Audi	31	28	12	4	(3)	28	12	4	(6)	24	34	15
♌	5	Tinha masa	Auvani	31	2	10	3	(3)	12	10	3	(2)	26	44	18
♍	6	Canyà masa	Paratasi	30	27	22	3	(2)	27	22	3	(4)	51	6	21
♎	7	Tula masa	Arpesi	29	54	7	2	(1)	54	7	2	(6)	48	13	23
♏	8	Vrischica masa	Cartiga	29	30	24	1	(1)	30	24	1	(1)	18	37	24
♐	9	Dhanus masa	Margali	29	20	53	1	(1)	20	53	1	(2)	39	30	25
♑	10	Macara masa	Tye	29	27	16	1	(1)	27	16	1	(4)	6	46	26
♒	11	Cumbha masa	Maussi	29	48	24	2	(1)	48	24	2	(5)	55	10	28
♓	12	Min masa	Poongoni	30	20	21	2	(2)	20	21	2	(1)	15	31	30

(*) The Ahargana of the Vachij is 1132665d. 1g. 15v, and according to their account the Solar year 3102 began on *Sunday* the 14th March A. D. 1. But it may be perceived that in reality there is but 6g. 24v. 15p. difference: the fraction of days of the greater sum, being 1g., and of the lesser 54g.

There remains now only to explain how the rest of Table II was constructed.

For the Cycles.

	D.	G.
To the Atchù, or Epoch above found - -	(6)	4
Add for 90 years - - - -	(1)	15
Root for the second Cycle - - -	(0)	19
And for all succeeding Cycles add - -	(1)	17
3d Cycle - - - - -	(1)	36
	(1)	17
4th Cycle - - - - -	(2)	53
	&c.	

For the odd years of the Cycles.

The Roots of the odd years of the Cycles are obtained by adding (1^d) 14^g to the *odd* and (1^d) 15^g to the even ones, excepting the 40th and 80th, to which, altho' *even* ones, (1^d) 16^g instead of (1^d) 15^g are to be added, for the reasons explained at page 52.

The difference of two guddias (1^d) 15^g) added to the Atchù of the first for obtaining the Root of the second Cycle less than, for the rest is probably a *Sodium*, or constant quantity subtracted from the result, to fit a particular epoch, which we would term an *Empyrical* equation, the same being called *Cshepa* when additive: at least I have not been able to discover on what theory the difference is established.

Rules for finding the beginnings of the years by Table II.

How to find the beginning of the year by the Tables.

In order to find the commencement of any proposed year by this Table, we must first find the number of Cycles and years expired from the beginning of the Cali yug; then take particular notice whether the remainder indicates an *odd* or *even* year; and lastly, whether it be the 40th, or 80th of the Cycle.

After summing up the Roots for the Cycles (column 1) and for the year (column 2), you are to add 31 viguddias in *even*, and subtract 29 in odd years, excepting the 40th and 80th of the Cycle, which require (though these be *even* ones) that 29 guddias be subtracted from the sum.

How to find by Table II the commencement of the Solar year of the Cycle of 90.

Let the year of the Cali yug 4847 current or 4846 complete, be proposed, and its beginning required.

1° From - 4846
Subtract - 3102
Christian year to be used in the computation 1744

2° 90)1744(19
34
add 24 or by the Hindu account - 4846 − 3078 = 1768; 90)1768(19, 868 and 58
58
19 Cycles, 58 years.

		D.	G.	V.	P.
3° Referring at 19 to the column of Cycles in Table II, we have -	19c	(2)	25		
And at 58 in the column of years - - - -	50y	(6)	56		
	8	(3)	4		
		(5)	25		
And on account of the year being even - - -	add	+	0	31	
	Friday	(5)	25	31	0
The same according to the Vachij - - - -		(5)	25	6	15
	Difference			24	45

The rest of the operation is in every respect similar to that employed in the resolution of the beginning of the Tamul year; the *Vachij* and *Sittandij* counting the Civil and Sydereal duration of the years and months in the same manner.

The Rules of the Northern and Southern Tamul Astronomers compared.

I shall conclude this exposition of the method of the Southern Astronomers, by giving some Rules for comparing its results with those of the Northern account, to facilitate which, I shall present the two Rules simultaneously expounded.

Example I.

Let the 1st year current of the 1st Cycle current, be proposed: wanted the time of its beginning, by both Rules.

Caution.

1° The year 0, of Cycle 0 of the Epoch of the Sittandij, corresponds to A. Ante Christum 24 and to that of the Cali yug 3078.

2° The year is an even one.

Sittandij.

	D.	G.	V.
For 0 Cycle, Table II, -	(6)	4	
For 0 year, part 2d - -	(0)	0	
	(6)	4	
The year being an even one, add			31
Root of beginning	(6)	4	31

Vachij.

	D.	G.	V.	P.
By Table VIII, A. A. C. for 20 years - -	(4)	6	21	15
By Table I, for 4 years complete - -	(5)	2	5	0
	(6)	4	16	0
Sittandij - -	(6)	4	31	0
Difference Sittandij, +			14	45

Example II.

Let the 41st year current of the 1st Cycle current, or 40th year complete of Cycle 0, be proposed: proceeding as before, this year will be found to correspond to A. D. 17.

Caution.

As 17—1=16 is to be used, this is an *even* year; but it is the 40th of the Cycle (vide page 53).

RULE.

Sittandij.

	D.	G.	V.
By Table II, part 1st, 0 Cycle	(6)	4	
Do. part 2d, 40 years	(1)	21	
	(0)	25	
But the year is the 40th of the Cycle, therefore subtract —	(0)	0	29
	(0)	24	31

Vachij.

	D.	G.	V.	P.
Table VIII, A. D. 0 -	(1)	16	46	15
Table I, 10 years - -	(5)	35	12	30
Do. 6 years - -	(0)	33	7	30
	(0)	25	6	15
Sittandij - -	(0)	24	31	0
Difference Sittandij —			35	15

EXAMPLE III.

Let the 46th year current of the 6th Cycle current, or 45th complete year of the 5th Cycle complete, be proposed. This year will be found to correspond to A. D. 472, and therefore 472—1=471 is to be used.

CAUTION.

This year is an odd one, therefore 29^v are to be subtracted.

RULE.

Sittandij.

	D.	G.	V.
Table II, part 1st, 5 Cycles	(5)	27	
Do. part 2d, 40 years	(1)	21	
Do. 5 years	(6)	18	
	(6)	6	
But the year is an odd one, therefore subtract - -			29
	(6)	5	31

Vachij.

	D.	G.	V.	P.
Table VIII, A. D. 0 -	(1)	16	46	15
Table I, 400 years - -	(6)	28	20	0
Do. 70 - -	(4)	6	27	30
Do. 1 - -	(1)	15	31	15
	(6)	7	5	0
Sittandij - - -	(6)	5	31	0
Difference Sittandij - —		1	34	0

EXAMPLE IV.

Let the 81st year current of the 20th Cycle current, or 80th complete of the 19th complete, be proposed, it will answer to A. D. 1767 ; and as 1766 is to be used, it is an *even* one.

RULE.

Sittandij.

	D.	G.	V.
By Table II, part 1st, 19 Cycles	(2)	25	
Do. 2d, 80 years	(2)	42	
	(5)	7	
But this year is the 80th of the Cycle, therefore subtract -			29
	(5)	6	31

Vachij.

	D.	G.	V.	P.
Table I, Epoch 1700 - -	(6)	2	11	15
Do. for 60 years -	(5)	31	15	0
Do. 6 years -	(0)	33	7	30
	(5)	6	33	45
Sittandij - - -	(5)	6	31	0
Difference Sittandij —			2	45

It will be perceived that the greatest difference between the Northern and Southern account falls on A. Cal. 3574, or A. D. 472, being $1^g\ 31^v$.

END OF THE FIRST MEMOIR.

SECOND MEMOIR.

A KEY TO THE SIDDHANTA CHANDRA MANA,

OR

HINDU LUNI-SOLAR YEAR,

PRINCIPALLY USED BY THE

INHABITANTS OF TELLINGANA, OR THE NORTHERN CIRCARS.

Written in the years 1823 and 1824.

ADVERTISEMENT.

On entering into the consideration of a method of dividing and recording time unlike any that ever was devised by man in ancient or modern times, the best warning that can be given to the reader is, to spare his attention by discarding all speculative matter, and to lead him speedily through a regular exposition of the doctrines on which that system is founded. I shall, therefore, offer but a few words by way of preface to this second Memoir, and these merely to prevent the reader from falling into the same misconceptions as I entertained when I began the present research.

It was imagined by some learned commentators, that the Hindu Astronomical Luni-solar year might be the same as some of those used by the ancients; and doubts immediately arose from that supposition, whether the Babylonians, Egyptians or Indians were the original inventors? To which I shall reply that, although certain features of resemblance may be discovered, yet neither the Mundane æra and year of the Jews, nor the Chaldean *Saros*, or *Sossos* (of which we know very little) have more to do with the Siddhanta *Chandra mana*, than any like division of time, where it was attempted to take into consideration and combine the Sun and Moon's revolutions.

The Luni-solar year of the ancients best known to us, reckoned that 99 Lunar months contained 2923 days and 12 hours; which in 60 years, gave an excess over the Sun's mean motion, of 3 days, and of 30 days in 160 years; on which account they *omitted* one of the intercalary months. This period being one of the three (viz. 19, 141 and 160 years) when the Hindus *seem* also to expunge a Lunar month, I was led, with other speculators, to suppose that the operation might be the same: but it soon appeared manifest to me from the present research, that the Hindus really *expunge nothing*, since it is only when a *double* intercalation is called for on their principles, that some other month is left out, so that when this case occurs, the year remains (as in all Embolismic years) one of 13 months, the only difference being, that the intercalation falls out of its usual place.

In the same manner, the order of the common intercalations during the Cycle of *Meton* appeared accidentally (from hitting on a particular period) to be the same as that of the Hindus; for the ancients divided their Cycle of 19 years into 12 *complete* and 7 *incomplete* years, which last they intercalated so that their equations fell on the 3d, 6th, 8th, 11th, 14th, 17th, and 19th, as was the practice of the Jews; and there are truly periods when the Hindu intercalations follow the same course.

But on looking deeper into the subject I found, that the series in the Hindu Cycle was in a constant state of *fluctuation*; *for on tracing* the successive intercalations, according to Indian principles, from the origin of the Cali yug, I found that they ran successively through every possible change, as may be seen in the marginal note (*), a circumstance which is the necessary consequence of a system according to which nature is always suffered to follow its own course, and in which the intercalations bear only on the *names* of the months, and the length of the artificial year, without the least quantity being thrown in to fit the lesser divisions of time to the system.

The same thing may be said of the Luni-solar days called *Tidhis*, these being likewise liable *in appearance* to intercalations and omissions, but not so in reality: for these circumstances depend entirely on the manner of coupling them with the corresponding solar days.

The truth is, that the Hindu Mathematicians seem, of all others that have existed, to be those who have shewn the greatest aversion to arbitrary equations; for although in our still imperfect knowledge of their Astronomy, the Hindu system appears not to be wholly free from empiricism, yet, as far as we are able to judge, the spurious quantities which we are unable to account for, may have been thrown in by them, less from choice than from necessity.

The adherence of the Hindus to that singular species of days which they call Tidhis, so unavailing to the purposes of civil life, is a striking proof, (among many others) of their attachment to ancient usages, for if on one hand it must be admitted, that without the use of these Tidhis their whole system of Astronomy must fall to the ground, on the other, as their beginning or end cannot be known without looking into the Panchangum, (because each may begin or end at any instant of the Solar day), it is difficult to conceive the cause which has

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(*) Series of Intercalations in the Hindu Cycle of 19 years from the year 0 to 779 of the Cali yug.

From A. Cal. 0 to,.

Years.	Months.	Days.	Gud.	Vig.		Revolutions.		Series of Intercalations.							
132	10	7	11	55)	7×19		1	0	3	6	9	11	14	17	19
246	8	24	56	25)	13×19	6	2	0	3	6	8	11	14	17	19
398	6	21	35	45)	21×19	8	3	0	3	6	8	11	14	16	19
512	5	6	20	15)	27×19	6	4	0	3	5	8	11	14	16	19
645	3	13	32	10)	34×19	7	5	0	3	5	8	11	13	16	19
778	1	20	44	5)	41×19	7	6	0	2	5	8	11	13	16	19
							7	0	2	5	8	10	13	16	19

Therefore in 779 years, the series of intercalations was interrupted 6 times.

779 = [illegible]

preserved their notation during so many ages in their rustic Kalendars, unless it be ascribed to their predilection for Astrology.

In truth the Tidhi is now almost entirely banished from public business, excepting in that part of India which was formerly called *Tellingana*, better known to Europeans under the name of the *Northern Circars*. But neither the testimony of the senses, nor the language of reason, could ever remove it from the moral and even physical concerns of the Indians, all believing alike, without distinction of castes or persuasions (*), that every contingency of life is ruled by the joint operation of the great luminaries of nature.—In all that relates to health, fortune, advancement, prosperity, or their contraries, the Panchangum must previously be consulted ; but the ruling order of the Brahmins rigorously require from those among them who are qualified for, and willing to compute it, that they will scrupulously adhere to those sacred doctrines according to which the beginning and duration of the Tidhi is determined, a period, however, (it must be owned) which is no further imaginary than because it is manifested to the senses by no visible operation of nature, though it be as truly an assignable portion of time, as the Solar day is an assignable part of the Sun's tropical revolutions.

(*) In the year 1800 the Author was Member of a Court Martial which had been assembled at Nundidroog for the purpose of trying a Mahommedan Sirdar of Rank named Hyder Beg, on an accusation of high treason.—This man was honorably acquitted, and after the sentence had been confirmed, the President of the Court proceeded to the place of his confinement to announce him his deliverance.—Hyder Beg received this communication with calm gratitude, but asked leave to remain in his prison until his family might arrive to be present at his liberation, which was granted.—Two days afterwards his principal wives and children reached Nundidroog in expectation of an immediate interview ; but during that interval a Brahmin *Astrologer* had got access to the Prisoner (himself a Mogul) and assured him that according to the *Panchangum* the Tidhi was an *unlucky* one, and that if he were to meet any of those who were dear to him pending its duration, they would feel the evil consequences ever after. Hyder Beg, though a grave and sensible old man, submitted to the imposition, and waited patiently until the end of the fatal Tidhi, for receiving to his bosom those dear objects whom, during the course of his trial, he had often thought he should see no more.

A

KEY TO THE SIDDHANTA CHANDRA MANA.

PART I.

ARTICLE 1.

ALTHOUGH there are short methods for computing the elements which are required for the construction of the Luni-solar Kalendar of the Tellingas (as it is improperly called in Madras) consistently with the doctrines of the Surriah Siddhanta, yet as these give no distinct view of the theories from which they are derived, I shall begin by computing each in Sydereal time according to the Rules of the Sastras, and show afterwards and in separate articles, how the same may be obtained by different processes.

As the division of time we are about to treat of is not a *Lunar*, but a *Luni-solar* year, the Solar Kalendar for that which it may be proposed to expound, must first be constructed, at least to a certain extent, according to the Rules delivered in the Key to the Madhyama Saura mana; such a document being indispensable at every step of the problem under consideration. The construction of the leading points of the *Ravi Panchangum* requires no considerable waste of time nor labour, and may be framed, by help of the Tables given at the end of the Memoirs, in the course of a few minutes, care being taken to use those which are constructed with the elements of the Surriah Siddhanta.

There are also certain quantities and expressions which are constantly required in the process, and which it is important not to mistake: Such are the names of the Hindu Signs of the Zodiac, with their numerical succession, both current and complete; the absolute number of days which the Sun takes to move through each Sign, the number of complete natural days in each Solar month, both Civil and Sydereal; and lastly, the numbers which are to be added to the Solar, or Luni-solar Aharganas on the beginning of the proposed year, for obtaining the Epochs of recurrence of mean conjunctions during the whole of its duration.

My intention being to expound every case of variation to which the Luni-solar year is subject, I have selected for exemplification the year 4924 current of the Cali yug, or 1745 from the birth of Salivahana, corresponding mainly with A. D. 1822; that on which Mr. Davis has announced there would be a *Cshaya*, or expunged month, and which exhibits consequently all the changes that are to occupy our attention. I annex the Skeleton of the Chandra Panchangum for that year, in order to familiarize the reader at an early period with its singular appearance.

As every means are given in the first Memoir for ascertaining the Solar date of any Epoch proposed in European time and vice versa, and as in the present tract I shall show that the *Tidhi* cannot be expounded without a knowledge of the corresponding Solar date, both of which are always inserted in the Chandra Panchangum, it would be useless to enter again into an explanation of the process by means of which the dates expressed in one style are to be converted into another, but the operation will be performed without comments, whenever it may be required.

Quantities required for the computation of the Luni-solar Kalendar for the same year.

Skeleton of the Solar Kalendar for the year Cali yugam 4924, and Saca 1745 current (A. D. 1822.)

Years current.	Number of Lunations.	Collective number of days in Lunations.	Collective number of days of Solar months.	Names of Luni-solar months.	Names of Solar months.	Roots of beginnings of months.	Sydereal duration of months	Civil duration of months	Names of Zodiacal Signs.	Types.	Sign Current	Sign complete	Beginning of months European dates.
4923	0	D. G. V. P. 0 0 0 0	D. G. V. P. S. 365 15 31 31 24	Chaitra	Poongoni	Roots D. G. V. P. (2) 22 17 4 36			Min	♓	12	11	12 March
	Lunations												
4924	1	29 31 50 7	30 55 32 2 39	Vaisácha	Chaitram	(4) 42 38 7 12	30	31	Mésha	♈	1	0	11 April
	2	59 3 40 14	62 19 44 5 20	Jyaisht'a	Vyassei	(0) 38 10 7 51	31	31	Vrĭsha	♉	2	1	17 May
	3	88 35 30 21	93 56 22 8 4	A'sha'd'ha	Auni	(4) 2 22 12 32	32	31	Mid'huna	♊	3	2	13 June
	4	118 7 20 28	125 24 34 10 46	Sra'vana	Audi	(0) 39 0 15 16	31	32	Carcáta	♋	4	3	14 July
	5	147 39 10 35	156 26 44 13 26	Bha'dra	Aurani	(4) 7 12 17 58	32	31	Sinha	♌	5	4	15 Aug.
	6	177 11 0 42	186 54 6 16 4	Aa A'swina	Paratasi	(0) 9 22 20 38	31	31	Canyà	♍	6	5	15 Sept.
	7	206 42 50 49	216 48 13 18 39	Na A'swina	Arpesi	(2) 36 44 23 16	30	31	Tulà	♎	7	6	15 Oct.
	8	236 14 40 56	246 18 37 21 12	Ca'rtica	Cartiga	(4) 30 51 25 51	30	30	Vrischica	♏	8	7	14 Nov.
				Cshaya									
	9	265 46 31 3	275 39 30 23 43	Ma'rgasiras Pausha	Margali	(6) 1 15 28 24	30	29	Dhanus	♐	9	8	14 Dec.
	10	295 18 21 10	305 6 46 26 15	Ma'gh	Tye	(0) 22 8 30 53	29	29	Macara	♑	10	9	12 Jan.
	11	324 50 11 17	334 55 10 28 48	P'halguna	Maussi	(1) 49 24 33 25	29	30	Cumbha	♒	11	10	10 Feb.
	12	354 22 1 24	365 15 31 31 24	Aa Chaitra or Phulguna Mulick	Poongoni	(3) 37 48 35 58	30	30	Min	♓	12	11	12 March
4925	13	383 53 51 31	30 55 32 2 39	Na Chaitra	Chaitram	(5) 58 9 38 34	30	30	Mésha	♈	1	0	11 April

How to find the Solar Ahargana for the 1st Chaitram of the year 4924 of the Cali yug, by means of Table XLVIII according to the Surriah Siddhanta.

	YS.		D.	G.	V.	P.	S.
Part 2, Columns 3 and 4, for	4000	-	1461035	1	33	20	0
do. -	900	-	328732	52	51	0	0
Columns 1 and 2 -	20	-	7305	10	30	28	0
do. -	3	-	1095	46	34	34	12
			1798168	51	29	22	12
Sodhyam or Equation		—	2	8	51	15	0
Ahargana 1st Chaitram 4924 - -			1798166	42	38	7	12
Subtract absolute duration of Poongoni		—	30	20	21	2	36
Ahargana 1st Poongoni 4923 - -			1798136	22	17	4	36

Divide each Ahargana by 7)1798166(256880 weeks

For Chaitram 4924 remainder 6 which counted from Friday gives Thursday, which according to Tabular expression counting from Sunday is to be noted (4d) 43g 38v 7p 12s as above.

7)1798136(256876 weeks

Remainder 4 which counted from Friday gives *Tuesday*; and according to Tabular expression counting from Sunday is to be noted (2d) 23g 17v 4p 36s as above.

Constant Quantities required for the Construction of the Kalendar of any Luni-solar year.

		Names of Solar months.	Absolute number of days in each Solar month.	Separate Roots of do.	Collective Roots of do.	European months N. S.
			D. G. V. P. S.	Roots. G. V. P. S.	Roots. G. V. P. S.	
1	♈	Chaitram	30 55 32 2 39	(2) 55 32 2 39	(2) 55 32 2 39	April
2	♉	Vyassei	31 24 12 2 41	(3) 24 12 2 41	(6) 19 44 5 20	May
3	♊	Auni	31 36 38 2 44	(3) 36 38 2 44	(2) 56 22 8 4	June
4	♋	Audi	31 28 12 2 42	(3) 28 12 2 42	(6) 24 34 10 46	July
5	♌	Auvani	31 2 10 2 40	(3) 2 10 2 40	(2) 26 44 13 26	August
6	♍	Paratasi	30 27 22 2 38	(2) 27 22 2 38	(4) 54 6 16 4	September
7	♎	Arpesi	29 54 7 2 35	(1) 54 7 2 35	(6) 48 13 18 39	October
8	♏	Cartiga	29 30 24 2 33	(1) 30 24 2 33	(1) 18 37 21 12	November
9	♐	Margali	29 20 53 2 31	(1) 20 53 2 31	(2) 39 30 23 48	December
10	♑	Tye	29 27 16 2 32	(1) 27 16 2 32	(4) 6 46 26 15	January
11	♒	Maussi	29 48 24 2 33	(1) 48 24 2 33	(5) 55 10 28 48	February
12	♓	Poongoni	30 20 21 2 36	(2) 20 21 2 36	(1) 15 31 31 24	March

The Roots between parenthesis to be counted from Sunday: But those given in the present Table being *absolute*, are never expounded but when combined with the initial Root of the proposed year. Vide marginal note of Table III (Madhyama Saura Mana),—the only difference being in the quantities, which in that Table are derived from the Elements of the Ariah Siddhanta.

SKELETON *of the Siddhanta Chandra Panchungum, for the Meridian and Latitude of* Madras, *for the* 4924*th Luni-solar year of the Cali yug.*

Chaitra. 1.			
Podugoni			
13	Sun	1	Soocha Pachum.
14	Mon	2	
15	Tues	3	
16	Wed	5	4 Cshaya.
17	Thurs	6	
18	Fri	7	
19	Sat	8	
20	Sun	9	
21	Mon	10	
22	Tues	11	
23	Wed	12	
24	Thurs	13	
25	Fri	14	Purnima Tidhi Chrishna Pachum
26	Sat	15	
27	Sun	1	
28	Mon	2	
29	Tues	3	
30	Wed	4	
Chaitram.			♈
1	Thurs	5	
2	Fri	6	
3	Sat	7	
4	Sun	8	
5	Mon	9	
6	Tues	10	
7	Wed	11	
8	Thurs	12	
9	Fri	13	
10	Sat	14	
11	Sun	30	Amavasya
29			

Vaisacha. 2.			
12	Mon	1	Soocha Pachum.
13	Tues	2	
14	Wed	3	
15	Thurs	4	
16	Fri	5	
17	Sat	6	
18	Sun	7	8 Cshaya.
19	Mon	9	
20	Tues	10	
21	Wed	11	
22	Thurs	12	
23	Fri	13	
24	Sat	14	
			Adigah.
25	Sun	14	Purnima Tidhi. Chrishna Pachum.
26	Mon	15	
27	Tues	1	
28	Wed	2	
29	Thurs	3	
30	Fri	4	
31	Sat	5	
Vyassei.			♉
1	Sun	6	
2	Mon	7	
3	Tues	8	
4	Wed	9	
5	Thurs	10	
6	Fri	11	
7	Sat	12	
8	Sun	13	
9	Mon	14	
			30 Cshaya.
29			

Jaish'ta. 3.			
10	Tues	1	Soocha Pachum.
11	Wed	2	
12	Thurs	3	
13	Fri	4	
14	Sat	5	
15	Sun	6	
16	Mon	7	
17	Tues	8	
18	Wed	9	
19	Thurs	10	
20	Fri	11	
21	Sat	12	
22	Sun	13	
23	Mon	14	
24	Tues	15	Purnima Tidhi. Chrishna Pachum.
25	Wed	1	
26	Thurs	2	
27	Fri	3	
28	Sat	4	
			Adigah.
29	Sun	4	
30	Mon	5	
31	Tues	6	7 Cshaya.
32	Wed	8	
Auni.			♊
1	Thurs	9	
2	Fri	10	
3	Sat	11	
4	Sun	12	
5	Mon	13	
6	Tues	14	
7	Wed	30	Amavasya.
30			

Asha'd'ha'. 4.			
8	Thurs	1	Soocha Pachum
9	Fri	2	
10	Sat	3	
			4 Cshaya.
11	Sun	5	
12	Mon	6	
13	Tues	7	
14	Wed	8	
15	Thurs	9	
16	Fri	10	Adigah.
17	Sat	10	
18	Sun	11	
19	Mon	12	
20	Tues	13	
21	Wed	14	
22	Thurs	15	Purnima Tidhi Chrishna Pachum.
23	Fri	1	
24	Sat	2	
25	Sun	3	
26	Mon	4	
27	Tues	5	
28	Wed	6	
29	Thurs	7	
30	Fri	8	
31	Sat	9	
Audi.			♋
1	Sun	10	11 Cshaya.
2	Mon	12	
3	Tues	13	
4	Wed	14	
5	Thurs	30	Amavasya.
29			

Sravana. 5.			
6	Fri	1	Soocha Pachum.
7	Sat	2	
8	Sun	3	
9	Mon	4	
10	Tues	5	
11	Wed	6	
12	Thurs	7	
13	Fri	8	
14	Sat	9	
15	Sun	10	
16	Mon	11	
17	Tues	12	
18	Wed	13	
19	Thurs	14	
20	Fri	15	Purnima Tidhi Chrishna Pachum.
21	Sat	1	
22	Sun	2	
23	Mon	3	
24	Tues	4	
25	Wed	5	
26	Thurs	6	
27	Fri	7	
28	Sat	8	
29	Sun	9	
30	Mon	10	
31	Tues	11	
32	Wed	12	
Auvani			♌
1	Thurs	13	14 Cshaya
2	Fri	30	Amavasya
29			

Bha'drapada. 6.			
3	Sat	1	Soocha Pachum.
4	Sun	2	
5	Mon	3	
6	Tues	4	
7	Wed	5	
8	Thurs	6	
9	Fri	7	Adigah.
10	Sat	7	
11	Sun	8	
12	Mon	9	
13	Tues	10	
14	Wed	11	
15	Thurs	12	
16	Fri	13	
17	Sat	14	Purnima Tidhi. Chrishna Pachum.
18	Sun	15	
19	Mon	1	
20	Tues	2	
21	Wed	3	
22	Thurs	4	
23	Fri	5	
24	Sat	6	
			7 Cshaya.
25	Sun	8	
26	Mon	9	
27	Tues	10	
28	Wed	11	
29	Thurs	12	
30	Fri	13	
31	Sat	14	
Paratasi			
1	Sun	30	♍
30			

Adigah Aswina. 7.			
2	Mon	1	Soocha Pachum.
3	Tues	2	
4	Wed	3	
5	Thurs	4	
6	Fri	5	
7	Sat	6	
8	Sun	7	
9	Mon	8	
10	Tues	9	
11	Wed	10	
12	Thurs	11	
13	Fri	12	
14	Sat	12	Adigah.
15	Sun	13	14 Cshaya.
16	Mon	15	
17	Tues	1	Purnima Tidhi Chrishna Pachum
18	Wed	2	
19	Thurs	3	
20	Fri	4	
21	Sat	5	
22	Sun	6	
23	Mon	7	
24	Tues	8	
25	Wed	9	
26	Thurs	10	
27	Fri	11	12 Cshaya.
28	Sat	13	
29	Sun	14	
30	Mon	30	Amavasya.
29			

The Siddhanta Chandra Panchangam, continued.

Nija Aswina. 8.			
Arpesi			♎ Soocha P.
1	Tues	1	Adigah.
2	Wed	1	
3	Thurs	2	
4	Fri,	3	
5	Sat	4	
6	Sun	5	
7	Mon	6	
8	Tues	7	
9	Wed	8	
10	Thurs	9	
11	Fri	10	
12	Sat	11	
13	Sun	12	
14	Mon	13	
15	Tues	14	Purnima Tidhi. Chrishna Pachum.
16	Wed	15	
17	Thurs	1	
18	Fri	2	
19	Sat	3	
20	Sun	5	4 Cshaya.
21	Mon	6	
22	Tues	7	
23	Wed	8	
24	Thurs	9	
25	Fri	10	
26	Sat	11	
27	Sun	12	
28	Mon	13	
29	Tues	14	
30	Wed	30	Amavasya.
30			

Cartica. 9.			
Cartiga			♏
1	Thurs	1	Soocha P.
2	Fri	2	
3	Sat	3	
4	Sun	4	Adigah.
5	Mon	4	
6	Tues	5	
7	Wed	6	
8	Thurs	7	
9	Fri	8	
10	Sat	9	
11	Sun	10	
12	Mon	11	
13	Tues	12	13 Cshaya.
14	Wed	14	Purnima Tidhi. Chrishna Pachum.
15	Thurs	15	
16	Fri	1	
17	Sat	2	
18	Sun	3	
19	Mon	4	
20	Tues	5	
21	Wed	6	
22	Thurs	7	
23	Fri	8	
24	Sat	9	
25	Sun	10	
26	Mon	11	
27	Tues	12	
28	Wed	13	
29	Thurs	14	
30	Fri	30	Amavasya.
30			

Cshaya Margasiras, Paushia. 10.			
Margali			♐
1	Sat	1	Soocha Pachum.
2	Sun	2	
3	Mon	3	
4	Tues	4	
5	Wed	5	
6	Thurs	6	
7	Fri	7	
8	Sat	8	
9	Sun	9	
10	Mon	10	
11	Tues	11	
12	Wed	12	
13	Thurs	13	Purnima Tidhi. Chrishna Pachum.
14	Fri	14	
15	Sat	15	
16	Sun	1	
17	Mon	2	
18	Tues	3	
19	Wed	5	4 Cshaya.
20	Thurs	6	
21	Fri	7	
22	Sat	8	
23	Sun	9	
24	Mon	10	
25	Tues	11	
26	Wed	12	Adigah.
27	Thurs	12	
28	Fri	13	
29	Sat	14	
Tye			
1	Sun	30	♑ Ama.
30			

Magha. 11.			
2	Mon	1	Soocha Pachum.
3	Tues	2	
4	Wed	3	
5	Thurs	4	
6	Fri	5	
7	Sat	6	
8	Sun	7	
9	Mon	8	
10	Tues	9	
11	Wed	10	
12	Thurs	11	12 Cshaya.
13	Fri	13	
14	Sat	14	Purnima Tidhi. Chrishna Pachum.
15	Sun	15	
16	Mon	1	
17	Tues	2	
18	Wed	3	
19	Thurs	4	
20	Fri	5	
21	Sat	6	
22	Sun	7	
23	Mon	8	
24	Tues	9	
25	Wed	10	
26	Thurs	11	
27	Fri	12	
28	Sat	13	
29	Sun	14	
Maussi			Adigah.
1	Mon	14	♒
2	Tues	30	Amavaysa.
30			

Phalguna. 12.			
3	Wed	1	Soocha Pachum.
4	Thurs	2	
5	Fri	3	
6	Sat	4	
7	Sun	5	6 Cshaya.
8	Mon	7	
9	Tues	8	
10	Wed	9	
11	Thurs	10	
12	Fri	11	
13	Sat	12	
14	Sun	13	
15	Mon	14	Purnima Tidhi. Chrishna Pachum.
16	Tues	15	
17	Wed	1	
18	Thurs	2	
19	Fri	3	
20	Sat	4	
21	Sun	5	
22	Mon	6	
23	Tues	7	
24	Wed	8	
25	Thurs	9	
26	Fri	10	
27	Sat	11	
28	Sun	12	
29	Mon	13	
30	Tues	14	
Poongoni			
1	Wed	30	♓ Ama.
29			

Adigah Chaitra, or Phalguna — itiek.			
2	Thurs	1	Soocha Pachum.
3	Fri	2	
4	Sat	3	
5	Sun	4	
6	Mon	5	
7	Tues	6	
8	Wed	7	
9	Thurs	8	
10	Fri	9	10 Cshaya.
11	Sat	11	
12	Sun	12	
13	Mon	13	
14	Tues	14	Purnima Tidhi. Chrishna Pachum.
15	Wed	15	
16	Thurs	1	
17	Fri	2	
18	Sat	3	
19	Sun	4	
20	Mon	5	
21	Tues	6	
22	Wed	7	
23	Thurs	8	
24	Fri	8	Adigah.
25	Sat	9	
26	Sun	10	
27	Mon	11	
28	Tues	12	
29	Wed	13	
30	Thurs	14	
31	Fri	30	Amavasya.
30			

Chaitra.			
Chaitram			♈
1	Sat	1	Soocha P.
2	Sun	2	
3	Mon	3	
4	Tues	5	4 Cshaya.
5	Wed	6	
6	Thurs	7	
7	Fri	8	
8	Sat	9	
9	Sun	10	
10	Mon	11	
11	Tues	12	
12	Wed	13	
13	Thurs	14	Purnima Tidhi. Chrishna Pachum,
14	Fri	15	
15	Sat	1	
16	Sun	2	
17	Mon	3	
18	Tues	4	
19	Wed	5	
20	Thurs	6	
21	Fri	7	
22	Sat	8	
23	Sun	9	
24	Mon	10	
25	Tues	11	
26	Wed	12	
27	Thurs	13	
28	Fri	14	
29	Sat	30	Amavasya.

Article 2.

General account of the Siddhanta Panchangum.

The Luni-solar year under consideration is accounted to begin at the true instant of conjunction, or new Moon, which precedes the commencement of the Solar year, with which it is mainly to concur; and is to be distinguished from the *Bhanu Husputtia mana*, which commences with the full Moon which precedes the same, the months of the former being termed *Mulchya*, or primary; those of the latter, *Gauna*, or secondary. The Bhanu Husputtia mana is not used in these parts of India.

The Chandra Mana is divided into twelve months, subject by intercalation to a thirteenth month, each, whatever be its real duration, being divided into 30 Tidhis.

Names of the Lunar months.

Names of the Lunar months.

1	Chaitra	5	Sravana	9	Margasiras or Agrahayan
2	Vaisacha	6	Bha'drapada	10	Paushia
3	Jyaish'ta	7	Aswina	11	Magha
4	A'sha'd'ha	8	Cartiga	12	Phalguna.

A Pacsha 15 Tidhis.

The month is divided into two parts of 15 Tidhis each, called *Pacsha* or *Pachum*, the first fortnight being denominated *Sukla* or Soocha (the enlightened), the second Chrishna or Bakoola (the dark) half of the month.

Names and duration of the Solar months.

Names and duration of the Solar months, (Surriah Siddhanta.)

	Bengal.	Tamul.		Absolute duration of each.					The same collectively.				
				D.	G.	V.	P.	S.	D.	G.	V.	P.	S.
1	Vaisa'cha	Chaitram	♈	30	55	32	2	39	30	55	32	2	39
2	Jyaish'ta	Vyassei	♉	31	24	12	2	41	62	19	44	5	20
3	A'sha'd'ha	Auni	♊	31	36	38	2	44	93	56	22	8	4
4	Sra'vana	Audi	♋	31	28	12	2	42	125	24	31	10	46
5	Bha'drapada	Auvani	♌	31	2	10	2	40	156	26	44	13	26
6	A'swina	Paratasi	♍	30	27	22	2	38	186	54	6	16	4
7	Ca'rtiga	Arpesi	♎	29	54	7	2	35	216	48	13	18	39
8	Ma'rgasi'ras	Cartiga	♏	29	30	24	2	33	246	18	37	21	12
9	Paushia	Margali	♐	29	20	53	2	31	275	39	30	23	43
10	Ma'gha	Tye	♑	29	27	16	2	32	305	6	46	26	15
11	P'ha'lguna	Mausi	♒	29	48	24	2	33	334	55	10	28	48
12	Chaitra	Poongoni	♓	30	20	21	2	36	365	15	31	31	25

The duration of these months, which is derived from the elements of the Surriah Siddhanta, and is that used by Tellinga Astronomers, differs from that which proceeds from those of the Ariah Siddhanta only in the ratio of $\frac{365\ \ 15\ \ 31\ \ 31\ \ 24}{365\ \ 15\ \ 31\ \ 15}$. The Tamul Astronomers, however, prefer the latter, even in their Lunar computations; and on that account the Solar Ahargana given in the General Table II, was computed with the Solar year of 365d 15g 31v 15p.

The instant of true conjunction which determines the commencement of the month is called *Arca-Indoo-Sanyama*, literally meaning conjunction of the Sun and Moon. It is also called *Durcham*, but more generally *Amavasya*.

Amavasya Tidhi. Day of conjunction.

Although the instant of conjunction be that which determines the commencement of the year or month, yet the day on which it occurs, and which on that account is called the *Amavasya* Tidhi, is always reckoned in the Kalendar, as well as in account, as the 30th *Tidhi* of the Lunar month, because it ends on that instant. The *Prathama* or first *Tidhi* of the ensuing month is always accounted to be the next, for the same reason.

Purnima Tidhi. Day of opposition.

The day of opposition is called Purnima Tidhi, and is always the 15th of the first Pacsha (*). The names of each Tidhi in each Pacsha or fortnight, are as follows:

Names of the days of the Pacsha.

1	Padyami	6	Shusti	11	Yacadesi
2	Vidya or Duitia	7	Suptami	12	Duadesi
3	Tadya	8	Astami	13	Tryadesi
4	Chouti	9	Navami	14	Chaturdesi
5	Punchami	10	Desami	15	Pavarnami

These names, which are merely numerals, will probably strike the reader, from their frequent resemblance to Latin words of the same import.

In the Panchangum the days are numbered no farther than fifteen, but in computations the series is followed up to thirty. It is, however, customary in numbering the last Pacsha in the Kalendar, to mark the 15th or last Tidhi (Pavarnami) *the 30th*, although the preceding one be noted the 14th and sometimes the 13th, unless the said 30th or Amavasya Tidhi should happen to be a *Cshaya* or expunged day; in which, and similar cases, it would be left out of the column, and (together with its duration) noted in the margin. The last day of the month when this occurs is registered the 14th; as was the case in the month of Vaisacha of the year 4921 (†) current.

Although the Cycle of 60 years (Vrihaspati) has no immediate reference to the Chandra

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(*) The Tamuls, and generally the Natives on the Coast, where their language is prevalent, with few exceptions, pronounce very badly all these names; and when they write them in English, it is difficult to recognize them. I have followed Sir William Jones, Mr. Davis and Mr. Scot's orthography, and I think it desirable that it should be maintained.

(†) Vide Kalendar, page 67.

Mana, yet I find in an old manuscript in my possession, that the Southern Astronomers use it for obtaining the Ahargana (*). The practice, however, not being general; I barely mention it. But it is customary every where to annex the name of the concurrent Vrihaspati year to the proposed Chandra Mana. (†)

Manner of dating.

This, and other practices, lengthen considerably the common manner of dating letters and other documents, for if an inhabitant of the country which is still sometimes called Tellingana, wishes to be very precise in dating a letter or bill of exchange, which let it be the 2° Tidhi of the intercalary month Aswina of the Luni-solar year Cali yugam 4924; his notation will be as follows:

"Chitrabhanù sumvat saram; Adigah Aswina; Suddha Duitya, Mangala-vara, Cali yugam "4924; Saca 1745."

ANGLICE.

Manner of dating in Tellingana.

In the year Chitrabhanù (the 16th of the Cycle of 60 Tellinga account)—of the intercalary month Aswina the 2d day,—Tuesday; A° Cali yugam 4924, and Saca 1745.

The Solar Kalendar, that for public business.

I am informed that this style in ancient times generally prevailed in all Tellingana; not only for private, but for public transactions. In latter times, however, it was found so extremely inconvenient (particularly since the introduction of the British power), that it was banished from all cutcheries, and the Solar Kalendar became that of the state. It is, however, still retained by the Brahmins, and most merchants at Masulipatam, Vizagapatam, Ganjam, and other places in the Northern Circars.

The following terms and definitions require particular attention.

Sumvat saram, name of a common year.

1° When the year is a common one, it is called by the general name of *Sumvat saram, or mana.*

Adigah Sumvat saram, an intercalary year.

2° An intercalary year—*Adigah Sumvat saram.*

Cshaya Sumvat saram, a double intercalary year with an expunged month.

3° A double intercalary year, and consequently affected with an expunged month—*Cshaya Sumvat saram.*

4° When a month is intercalated, the word *Adigah* is prefixed to it (meaning added). Thus

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(*) What follows is a literal translation of the article referred to.

"Three things are requisite for determining the time of an Eclipse, viz. 1° The Soota dina, or the last of "the number of days which have elapsed since the Epoch fixed upon by the Author of the Rule. Now that "Epoch falls on the 12th year of the Indian Cycle of 60 years; and there are elapsed (so it is supposed) 80 of "these Cycles until the year 1747, when the Cycle began anew. So multiplying 60 by 80, and adding 48 years "to the product (48 years remaining of the first Cycle), you have the number of years that have passed up to "the year 1747. Moreover, multiply the total sum by 365 days, 15 narikas, 31 vinadis (the Tamul names for "guddias and viguddias) and 15 tarparys (paras); add thereto the number of months, days, minutes, &c. elapsed "since the Astronomical or true beginning of the current year, and you have the precise day sought, &c. &c."

(†) These names are inserted in the General Table I given at the end of the Tables.

Adigah Aswina "intercalated *Aswina*" and *Nija* (or proper) *to the second*, repeating the name of the month.

5º In the case of two intercalations in the same year, Tellinga Astronomers call indistinctly the second intercalation by the name of the month which occasions it, or by that of the preceding month: adding   *itick* to it. Thus in the Patra for the year 4924 the last *Adigah* may either be called, *Adigah Chitra*, or *Phalguna .. itick*.

6º When an expunged month occurs, the name of that on which it falls is coupled with that which follows it; and the second is the month *proper*. Thus in the said year 4924, the expunged month falling on *Margasiras* (Agrahayan); the notation is *Margasiras Paushya*: and the latter is the *proper* current month.

Two Tidhis ending in a Solar day, the intermediate a *Cshaya*.

7º When *two Tidhis* end in a concurrent Solar day, the intermediate Tidhi is expunged out of the column of days in the Kalendar, and it is called a *Cshaya Tidhi*. The numerical series is therefore interrupted; but the omitted Tidhi, together with its duration, are registered in the margin. Thus we have in the month Cartiga (first Pachum) 11, 12, ✱, 14, 15, the 13th being registered out of the line as a *Cshaya*.

No Tidhi beginning or ending in the same Solar day an *Adigah*.

8º When no Tidhi begins or ends in a Solar day, the preceding is an *Adigah*, or intercalary day, and its numeral is repeated. Thus we have in the first Pachum of Vaisacha, 13, 14, ✱, 14, 15. The first Tidhi being accounted the intercalated, and the second the proper one.

A Tidhi beginning *before* Sun rise or *at Sun rise* belongs to the concurrent Solar day.

9º When a Tidhi is found to begin "*before Sun-rise*, or *at Sun-rise*" then it is accounted to belong to its concurrent Solar day.

A Tidhi beginning *after* Sun rise belongs to the ensuing Solar day.

10º When a Tidhi is found to begin "*after Sun-rise*," then it is taken to belong to the ensuing Solar day, "provided it does not end in the same day," because in such a case it would fall *within the* operation of article 7º, and would be expunged out of the column of Tidhis.

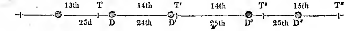
11º If a Tidhi be expunged, it is sometimes called *Avamaha*, or *Oopadi*, which means *advanced*. This circumstance happens on a medium, once in 64 days; so that in one year it recurs five or six times.

12º When a Tidhi is repeated twice, it is sometimes called *Tridina*, or *Sproohoo*; the most common designations however, are *Cshaya* for expunged; and *Adigah* for intercalated.

13º In the language of Tellinga Astronomers a Tidhi is a Luni-solar day; and a *Theidi*, a Solar day; a notation which it is necessary to remember when reading Hindu tracts, to avoid mistakes. *Theidi* means also a date.

The intercalary and expunged Tidhis purely nominal.

14º From the preceding articles it will be easily perceived that the introduction or omission of a Tidhi in the columns of the Kalendar, is purely nominal, which proposition may be illustrated in the following manner.



Let TT′ and T′T″ represent two Tidhis; and DD′, D′D″ two concurrent Solar days, then as T (14th) began *before Sun-rise*, it belongs to the 24th Vyassei (Solar Kalendar); but as T′ began *after Sun-rise*, it belongs not to the 25th, but to the 26th Vyassei (articles 9º and 10º), and so the 25th remains seemingly without an appropriate Tidhi. Hence it comes to pass that the preceding Lunar Tidhi (14th) is supposed *to go on* until the 26th Vyassei, whose concurrent Tidhi is therefore noted the 15th; and so forth for every possible case.

A constant recollection of this singular disposition, is indispensable to the clear understanding of the manner of registering the days and Tidhis in the Kalendar; and what renders it the more perplexed is, that although the Tidhis are computed according to *apparent time*, yet they are registered in *civil time*.

The Tidhis computed according to Sydereal time registered in Civil account.

The precise instant of the day after Sun rise in which the Tidhi ends, is the first article inserted in the margin opposite to it.

Article 2.

Independently of the preceding articles, the Ephemerides which always accompany the Panchangums, exhibit several others, five of which are given for every day, and the rest as there is occasion.—the five principal ones are as follows:

Articles of the Ephemerides annexed to the *Panchangum*. ↓

1º The Nacshatra in which the Moon is on the given day. 2º The *Yogà*, which though bearing the same names as the *Yoga*, has no reference to it, as shall be further explained. 3º The *Curna*. 4º. The *Thyagum* of the *Wurjum*, being the unlucky period of the day; the three last being Astrological Elements. 5º The *Isharum* or places of the Planets in the Lunar mansions on the given day.

I shall only speak of these five articles in this place, because the manner of computing them is given in the third Memoir; but there are eight others which, being purely astronomical or astrological, do not belong to our province; and therefore, those who wish for an account of the latter, will find it annexed to the specimen of the Ravi and Chandra Panchangums and Ephemerides inserted at the end of this work.

1º The Nacshatra, or Lunar mansion in which the Moon happens to be on each day.

There are 27 regular mansions in the circumference of the Moon's periodical revolution: each contains therefore 13° 20′ of her Zodiac. Sometimes an extraordinary Nacshatra, named *Abhijit*, is inserted between the 21st and 22d, in which case it takes 3° 20′ from the former, and 1° 40′ from the latter. The Tellinga Astronomers make no use of this extra Nacshatra.

The regular Nacshatras 27.

The extraordinary Nacshatra called Abhijit.

Each mansion is divided into 60 guddias, the guddia into 60 viguddias, &c. so that one guddia is equal to $13' 20''$, a viguddia to $13'' 20'''$, and a para to $13''' 20''''$, which denominations must not be confounded with the measure of time of the same names.—The mansion is more

The Nacs. divided into guddias, viguddias and paras.

generally divided into four quarters, called *Padahs*, which are always referred to in the Ephemerides.

The names of the 27 Nacshatras are as follows:

Names of the Nacshatras.

1	Aswini	11	Purva Phalguni	21	Uttara A'shád'hà
2	Bharanì	12	Uttara Phalguni	*	Abhijit
3	Criticà	13	Hasta	22	Sravana
4	Rohini	14	Chitra	23	Dhanish'tà
5	Mrigasiras	15	Swa'tì	24	Satabhisha
6	A'rdrà	16	Visac'ha	25	Purva Bhadrapada
7	Punarvasu	17	Anurádhà	26	UttaraBhadrapada
8	Pushia	18	Jyést'ha	27	Revati
9	Asleshà	19	Mula		
10	Maghà	20	Purva A'shád'hà		

In each Nacshatra there is a particular Star called *Yoga*, which serves as the index of the mansion. The following are their names, with those of the Stars of the European Catalogue which are supposed to be the same as the Yogas (*).

	Yogas.	Stars of the European Catalogue supposed to be meant.		Yogas.	Stars of the European Catalogue supposed to be meant.
1	Vishcambha	γ or β Arietis	15	Vajra	Arcturus
2	Príti	35 Arietis	16	Asrij or Siddhi	24 Libræ
3	Ayushmat	Alcyone	17	Vyatipáta	β Scorpii
4	Saubha'gya	87 Tauri	18	Vari'yas	Antares
5	So'bhana	either 113, 116, or 117 Tauri	19	Parigha	34 or 35 Scorpii
6	Atiganda	perhaps 133 Tauri	20	Siva	δ Sagittarii
7	Sucarman	β Geminorum	21	Siddha	φ Sagittarii
8	Dhriti	δ Cancri	*	Abhijit	α Lyræ
9	Sûla	49 or 50 Cancri	22	Sâdhya	α Aquilæ
10	Ganda	Regulus	23	Subha	ε Delphini
11	Vriddhi	perhaps 70 or 71 Leo	24	Sucra or Subra	λ Aquarii
12	Dhruva	β Leonis	25	Brahman	α Pegasi
13	Vyághâta	7 or 8 Corvi	26	Maha Indra	γ Pegasi
14	Hershana	Spica Virginis	27	Vaidhriti	ζ Piscium

(*) It is foreign to the object of this Paper to enter into an account of the position of these Stars in the heavens: all that I shall observe at this place is, that in taking their Latitude and Longitude out of the Hindu Tables their *Vicshipa* and *Sayana* (being corresponding terms), the former is to be considered as an arc of the Meridian which intersects the Star and the Ecliptic, and the latter as the portion of the Ecliptic which is intersected by the same Meridian and the Equinoctial Colure.

The Yogu or Yoga.

2°. The *Yogù* or *Yoga;* which, though bearing the same name, and in the same number as the *Yoga* stars exhibited in the preceding catalogue, yet has no Astronomical reference to it, is the time during which the sum of the motions of the Sun and Moon amounts to one *Nacshatra.* Thus if it be found to amount to 10g 10v of a Nacshatra in any Yogù (considered as the first) at 8g 59v of time, the following, or second *Yogù,* will begin at 5g 28v after Sun rise the next day. (*)

Its duration.

Number of Yogus.

Of the 27 *Yogùs,* named as the *Yogus,* of the respective Nacshatras, seventeen are nearly equal to sixteen days.

The Curna or Carana.

3°. The *Curna,* or *Carana*—is the time when the Moon's motion from the Sun amounts to 6°, there being two Caranas in one Tidhi. There are eleven *Curanas* in all, of which seven are ordinary and moveable, and named *Curra:* and four extraordinary and fixed, called *Sthirra.*

Their names.

The ordinary *Curnas,* or *Caranas* are specifically named as follows:

Ordinary.

1. Bhâva,
2. Bhalava,
3. Coulava,
4. Dhitalâ,
5. Yurka or Gurujah,
6. Warnaji,
7. Bhudra, or Vusti.

The Extraordinaries.

Extraordinary.

8. Soyami or Chaconi. 9. Chadespadah. 10. Nagava. 11. Cimastughna or Rhimustoguna.

Their disposition.

The first Curna begins when the Moon is 6° from the Sun; and the seven moveable ones being eight times repeated in successive order, include 342°.—The Moon's Synodical orbit being considered as divided into 360°, there remains 18° which she wants to complete her revolution; and these are allotted to the 8th, 9th and 10th Curnas; but the first six degrees after the conjunction belong to the 11th, or last.

The Tyajya of the Varjya.

4°. The *Tyájyá* of the *Varjya* (pronounced both by the Tamuls and Tellingas *Thyajum* of the *Wurjum*).—These terms are always employed together in the Kalendar, the *Varjya* being that portion of a Nacshatra which is deemed unlucky, and the *Tyájyá* the time of the duration of the unlucky period. This time is determined by a certain point in each Nacshatra called its *Dhruva:* that which the Moon's Disc takes, by her absolute motion, to traverse it, is the *Tyájyá;* and its mean duration is 4 guddias: but its true one more or less, according as the Moon's continuance in the same Nacshatra happens to be more or less than 60 guddias.

What determines the duration of the Tyajya.

The Charum or Padacharum.

5°. The Chárum or Pádachárum (pronounced Isharum by the Tamul astrologers)—a term used in the Hindu Ephemerides, signifying the daily aspect or position of the planets; answering to the same signification as *Jumna-patricá;* though the latter means more precisely their aspect at

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(*) The duration of a mean Yogu is 56g. 29v. 21p,75, but the apparent one varies in proportion with the Sun and Moon's respective apparent motions, which depends on the place of their Apogees and affords a vast variety of combinations. Vide page 174.

any instant of time. The manner of computing these will be found at page 182 of this work. (Vide also Glossary).

Supplementary articles of the Panchangum.

It would be a waste of time to enter into any further account of the other Astrological elements which are inserted in the *Chandra Panchangum*, independently of the five preceding ones, such as the *Crantum*, *Vethei*, and *Latta*. Some notice of these, however, will be taken in the IVth Appendix at pages 308 and following.

ARTICLE 3.

Computation of the mean Elements.

DEFINITION.

Definition of the mean Tithi.

Its duration 59g. 3v. 38p.

A mean Tithi or Tidhi, (a Lunar day) is the time during which the Moon moves through 12° of her Synodical orbit supposed to be divided into 360°; its duration is therefore 59g 3v 38p Hindu time, or 23h 37′ 27⅕″ European time: of these there are very nearly 371 in a Solar year. (*)

That of the true Tithi variable.

Depend principally on the revolutions of the Moon's Apogee.

The duration of the True, *Sphuta* or *Sputa Tithi* depends on the apparent relative motion of the Sun and Moon. For a very long time the duration of the true Tithi is not sensibly affected by the motion of the Sun's Apogee: but their longer or shorter duration depends principally on their occurring at the time when the Moon is nearer or further from her Apogee, the former being only of 387 revolutions in a *Calpa*, and the latter revolving 488203 times in a *Maha yug*.

ELEMENTS.

Elements.

The Elements which are required for computing the articles of the Luni-solar Kalendar, are principally as follows:

1º The Sun's mean place in the Hindu Ecliptic called *Ravi Madhyama Graha*.

2º The Moon's Do. *Madhyama Chandra Graha*.

3º The place of the Sun's Apogee in Do. called generally his upper Apsis, or *Ravi (Tunga) Mandocha*.

4º The Moon's Do. *Chandra Mandocha*.

5º The *Ayanansa*, or *Ayana Bhagas*,—meaning the arc comprised between the Vernal Equinoctial point *(Mesha Ayana)* and the first in the Hindu Sydereal Ecliptic. This latter Element is required for referring all the computations made on the fixed, or Sydereal, to the moveable, or Tropical Sphere.

6º The obliquity of the Ecliptic which the Hindus take to be constantly 24°.

All these Elements are to be resolved by means of the *Trin*, or *Trairás'ica* (more generally pronounced *Trirasica*), the common rule of three; and are therefore, no otherwise difficult to compute than on account of the immense dimensions of the quantities, with which the operations are to be performed. For all these we have the following data.

(*) Tellinga Astronomers allow something more for the length of the mean Tithi, which according to them is of 59g. 3v. 40p. 28s. Vide page 172.

Data.

Revolutions of the Sun Moon and their Apogees in a *Maha yug* or a *Calpa*.

1º The Sun performs 1320000 *Baghanas* or Sydereal revolutions in a Maha yug; and in the same period of time there are 1577917828 natural or *Bhumi Savan* days.

2º The Moon—57753336^{r} in the same period.

3º The Sun's upper Apsis—387^{r} in a *Calpa* or 1000 Maha yug, which Calpa, therefore, contains 1577917828000 *Bhumi Savan* days.

4º The Moon's Apogee—488203^{r} in a Maha yug, with an additive Bijah or correction of 4 revolutions in the same space of time.

Of the Equinoctial points.

5º The *Ayanas* or Equinoctial points, called sometimes *Cranti Patas*, or Nodes of the Ecliptic—600 *Revolutions* (or *Librations*, in whichever way it may please the computer to consider the Hindu precessional variation) in a *Maha yug*.

The revolutions of the Moon's ascending (*Rahu* the head) and descending Nodes (*Ketu* the tail of the Dragon), which proceed in *Antecedentia*, are not required for computing the common articles of the Kalendars, being only wanted for Eclipses and Occultations. Of these, however, there are 232238^{r} in a Maha yug, with a Bijah of 4^{r} as for the Moon's Apogee.

The Calpa, Sandhi, Manwantaras, Maha yug and 4 lesser yugs or periods.

These datas are thus presented, on a supposition that the reader is already informed that a *Calpa* consists of 4320000000 Solar Sydereal revolutions, with a Twilight, or *Sandhi* of 1728000 years—that this period contains 14 *Manwantaras*, each of which contains 308448000 years. That a Maha yug is equal to 4320000 years, comprehending *four* lesser yugs, or periods of conjunctions; viz. The *Satya yug* 1728000^{y} (equal to the *Sandhya* which precedes the *Calpa*)—the *Treta yug* 1296000^{y}—the *Devapar yug* 864000^{y}—and the Cali yug 432000^{y}; of the latter of which, in the year of Christ 1822, there were 4923 expired; the 4924th beginning on Thursday the 11th April of the said year, New Style.

Saura time expressed in degrees, &c.

That sort of time which the Hindus call *Saura*, may be converted into degrees, &c. by the following Table.

Hindu expression.	Surriah Siddhanta.	Tellinga.	Degrees.	Designation.
A Year	Sumvat sara	Mana	360°	12 Rasis or Signs
Month	Masha	Masha	30°	1 Rasi or 30 Bagahs
Day	Dina	Theidi	1°	1 Bagah
Hour	Danda	Guddia	$1'$	Cala
Minute	Vicala	Viguddia	$1''$	Vicala
	Pranacala		$10'''$	1 Pranacala
Second	Castacala	Para	$1''''$	Castacala

The time so expressed, may be converted into Solar Sydereal time by means of Table XVI.

FIRST OPERATION.

For the Strostidi Digona.

Strostidi Digona. The *Strostidi Digona* means the number of natural days expired from the beginning of the *Calpa*, or grand Astronomical Epoch when the Planetary motion commenced, to any proposed day. The rule for finding that period of time, though necessarily operose, is easily explained.

PRECEPT.

Precept. 1° Find the number of *Saura* years expired of the Calpa on that which is proposed, by adding together the *Sandhi* which precedes the Calpa; six Manwantaras; twenty-seven Maha yugs; the Satya; Treta; and Devapar yugs.—Subtract the number of years employed in the Creation, which is 17064000", and add to the remainder the years of the *Cali yug* expired: the sum is the Strostidi Digona in *Saura years*.

2° Multiply the same by 12, and you have it in *Saura months*.

3° There being 1593336 intercalary Lunar months in a Maha yug, find the number due to the Strostidi Digona in months, which add to the former.

4° Multiply the sum by 30, and you have the Lunar days or *Tidhis*.

5° There being 25082252 superabundant, or *Cshaya* Tidhis, in a Maha yug, find the number due to those found by article 4, which subtract from the same, and the remainder gives the Strostidi Digona in *Bhumi Savan* days.

Rule. These five operations are combined in the following Example for the year 4924 current of the Cali yug.

EXAMPLE I.

			Saura years.
1°	Sandhi or Twilight of the Calpa		1728000
	Six Manwantaras		1850688000
	Twenty-seven Maha yugs		116640000
	The Satya yug equal to the Sandhi		1728000
	The Treta yug		1296000
	The Devapar yug		864000
		Sum	1972944000
	Subtract time employed in the Creation	—	17064000
		Remainder	1955880000
	Add the years expired of the Cali yug		4923
	Strostidi Digona in Saura years		1955884923
2°		Multiply by	× 12
			3911769846
			1955884923
	The same in Saura months		23470619076

3º For the number of Intercalary or Adigah months due to *the same* period.

Say As the number of Saura months in a Maha yug - - 51840000
To the number of Adigah months in the same - - 1593336
So the number of months above found - - 23470619076
To the number of Adigah months sought

$\frac{1593336 \times 23470619076}{51840000}$ - - add + 721384689

Number of Lunar months - - - 24192003765

4º Multiply by - - × 30

Number of Lunar Tidhis - - - 725760112950

5º For the number of Superabundant Lunar days, and Strostidi Digona in Bhumi Savan days.

Say As the number of Tidhis in a Maha yug - - - 1603000080
To the number of Cshaya Tidhis in the same - - 25082252
So the number of Tidhis above found - - - 725760112950
To the number of Cshaya Tidhis sought

$\frac{25082252 \times 725760112950}{1603000080}$ Subtract — 11356018175

Strostidi Digona in Bhumi Savan days 714404094775

SECOND OPERATION.

For the Soota dina, or feria on which falls the last conjunction of the Luni-solar year 4923 *from the Cali yug.*

Soota dina or last day of conjunction.

The Strostidi Digona in Bhumi Savan or natural days being divided by 7

7)714404094775(102057727825 weeks

and the remainder 0 being counted from Saturday as *Zero* (because the Creation is supposed to have been completed on *Sunday*) shews that the Luni-solar year 4923 ended on a *Saturday*, which concurred therefore with the 30th or Amavasya Tidhi of the Lunar month Phalguna of the said year; and shews that the *Prathama Tidhi* or first day of 4924 fell on a *Sunday*.

ARTICLE 4.

Tellinga process Strostidi.

Before we proceed any further, we shall consider (with a view to save time) the method according to which Tellinga Astronomers compute the Strostidi Digona in Bhumi Savan days, without undergoing the trouble of the preceding long process.

Although the Precept disclosed in the 3d Article be the fountain head from which all other methods were derived, yet the extreme length of its operations has tempted modern Tellinga Astronomers to search for shorter Cycles wherein the ratio of the intercalary months and superabundant Tidhis might be preserved, and they have accordingly computed that in 180000 Saura years, there are exactly 66389 Adigah months; and that in 13358334 Lunar months, there are 6270563 Cshaya Tidhis. This Cycle of 180000 affords, therefore, a convenient proposition for computing some of the Elements with perfect accuracy, but from these are to be excepted the position of the Sun's Apogee, which (as we have already hinted) moves only at the rate of 1′ in 517 Saura years, and the precessional variation at that of 54″ in a year. These, therefore, require much longer periods, and for this object the following method was found perfectly competent.

PRECEPT.

Precept. 1º Compute the *Strostidi Digona* in Bhumi savan days by the Sastra rule for the end of the last day of the Devapar yug (vide Example I). This will be a constant quantity, to which if you add the *Ahargana*, or number of natural days expired from the beginning of the Cali yug to the proposed Epoch, you will have the *Strostidi Digona* for the same, just as if it had been computed by the long process.

EXAMPLE II.

Rule. Let the Strostidi Digona for the last day of the Devapar yug be required, for the purpose of deducing therefrom that for the last day of the year 4923 of the Cali yug.

1º Not to repeat what has already been done in the first Example, take the Strostidi in years for the end of the Devapar yug, as found therein; which is 195588000 Saura years: proceed as before, and you will have the same in months 23470560000. Hence for the Adigah months and Cshaya Tidhis,

$\frac{1593336 \times 23470560000}{518400000}$ Adigah months 721382874

Which add to the sum of months - - - 23470560000

Number of Lunar months - - - - 24191942874

Multiply by × 30

725758286220

and

$\frac{25082252 \times 725758286220}{1603000080}$ Cshaya Tid. Sub. — 11355989593

Strostidi Digona in B. Savan D. last of Devapar 714402296627

Now this quantity 714402296627 B. S. days once obtained, becomes a constant number, which combined with the Tellinga rule, will serve in future for finding the Strostidi Digona of all Epochs which do not ascend higher than the beginning of the Cali yug.

Ahargana. 2º For the *Ahargana*, or time expired from the commencement of the Cali yug to the end of the year 4923.

Say As the number of Saura years in the Cycle - - 180000
To the number of Adigah months in the same - - 66389
So the number of years of the Cali yug expired - - 4923
To the number of Adigah months sought which add -
$\frac{66389 \times 4923}{180000}$ - - - 1815
Then multiply 4923×12 number of months - - add 59076

Number of Lunar months sought 60891

For the superabundant days.

Say As the number of Lunar months, (see data, page 77) -	13358334
To the number of Cshaya Tidhis in the same - - -	6270563
So the number of Lunar months expired - - -	60891
To the number of Cshaya Tidhis sought $\frac{6270563 \times 60891}{13358334}$ - - - —	28582
Multiply the number of Lunar months 60891 by 30, it is -	1826730
From which subtracting the Cshaya Tidhis you have -	1798148

the *Ahargana* for the end of the year 4923.

3º For the feria of the last conjunction in that Luni-solar year.

Soota dina.

Divide the Ahargana by 7)1798148(256878

with a remainder of 2 which counted from *Thursday* as Zero (because the Cali yug began on a Friday) gives *Saturday*, as we found by the Sastra rule.

4º To deduce the Strostidi Digona for the same day from the preceding operations.

	B. S. Days.
To constant number - - - -	714402296627
Add Ahargana - - - - -	1798148
Strostidi Digona in B. Savan days - - -	714404094775

The same as found by the Sastra rule, the remainder of which, after division by 7, must be counted from Saturday as Zero, as before.

Independently of the method for finding the *Ahargana* above disclosed, there are shorter Cycles used in Tellingana, one of which will be wanted for resolving the place of the Planets by means of Vavilala Cuchinna's Tables; and a much shorter method will be shewn in a separate Note inserted at the end of the Memoirs, but we shall postpone noticing either until called for, in order not to crowd unnecessarily the matter on the reader's attention.

ARTICLE 5.

For the Hindu Solar and European dates of the Soota dina or feria of the last conjunction of the year 4923 of the Cali yug.

Hindu Solar and European date of the Soota dina.

Means were given in the first Memoir for finding the European date of any assignable Hindu Solar day; and to these we shall have recourse for finding that of the Amavasya, the Soota dina of which we have computed in the preceding Articles.

Solar Ahargana for *Chaitram* and preceding month *Poongoni.*

The duration of the Solar year according to the Surriah Siddhanta being $365^d\ 15^g\ 31^v\ 31^p\ 24^l$, multiply the same by 4923, and subtract the *Sodhyam* (subtractive equation) $2^d\ 8^g\ 51^v\ 15^p$, the remainder will be the Solar Ahargana sought. (*)

(*) The Ahargana may also be obtained with less trouble by means of Table XLVII, part 2d.

[illegible]

	D.	G.	V.	P.	S.
This Element will be found - - - - -	1798166	[43	38	7	12]
Neglect the fraction, and subtract the Luni-solar Ahargana computed at Article 4 - - - - - - —	1798148				
Difference - - - -	18 days.				

For the juxta position of the beginning of the Solar and Luni-solar years.

But by the respective Precepts, the remainder of the Solar Ahargana after division by 7, is to be counted from *Friday;* and that of the Luni-solar from *Thursday*, therefore when the Solar is the greatest of the two, *one* day is to be added to, and when least subtracted from, the difference. In the present case, the interval should therefore be increased by an unit, which makes it 19 days.

Now the remainder of 1798166, after division by 7, being 6, the same being counted from Friday, gives *Thursday;* and by the rules formerly delivered, will be found to fall on April 11th, A. D. 1822, *Sydereal*, and (and on account of the fraction $43^g\ 38^v\ 7^p\ 12^s$ which exceeds 30) on the 12th, *Civil* account. Subtract therefore 19 days from 11th April, and we find Saturday, 23d March N. S. the Sydereal date of the Soota dina sought.

We now want the Civil and Sydereal date in European expression, of the 1st day of the Solar month Poongoni, A. Cal. 4923, for which referring to Table III, we have

	D.	G.	V.	P.
Ahargana 1st Chaitram above found - - - -	1798166	43	38	7
Subtract absolute duration of Poongoni - - - —	30	20	21	2
Ahargana 1st Poongoni A. C. 4923 - - - -	1798136	23	17	5

and the sum of days after division by 7, leaving a remainder of 4 to be counted from Friday, indicates *Tuesday* the Soota dina sought.

Using, therefore, any Kalendar, and counting 30 days backwards from the 11th April, we find Tuesday the 12th March *inclusive*, (the 11th being the last day expired), which is the Sydereal date of the 1st Poongoni European account.

Again, the fraction $23^g\ 17^v\ 5^p$ (below 30) shews that on the beginning of that month the Sydereal and Civil account coincided, and since the 1st Poongoni fell on the 12th March *inclusive*, and the Luni-solar Soota dina on the 23d, it follows that the Solar date sought is the 12th Poongoni, and that the Sydereal and Civil account coincide; altho' on account of the fraction of the Solar Ahargana for 1st Chaitram 4924; $43^g\ 37^v\ 57^p$ (above 30) the Sydereal month is of 30, the Civil is of 31 days.

The date of the last *Amavasya*, 30th Phalguna of the year 4923, is therefore, *Saturday* the 12th; and that of the *Prathama* Tidhi, the 1st of the Lunar month Chaitra 4924, *Sunday* the 13th Poongoni of the Solar year 4923.

The following Elements are, therefore, all computed for the 12th Poongoni.

N. B.—A difference will be found between these results, and those which would be obtained if the Elements of the Ariah Siddhanta (those of the Solar Kalendar) were to be used; for the

	D.	G.	V.	P.
Ahargana for the 1st Chaitram of the Solar year 4924, on those principles, instead of (4ᵈ) 43ᵍ 38ᵛ 7ᵖ, would be - - - - -	(4)	20	12	30
From which subtract Root for Poongoni, Table III, column 1, - —	(2)	20	21	2
The Root of Ahargana 1st Do. - - - -	(1)	59	51	28

would be *Monday*, Sydereal account, instead of *Tuesday*, found by the process of the Surriah Siddhanta. But on account of the fraction 59ᵍ 51ᵛ 28ᵖ (exceeding 30) it would be *Tuesday*, *Civil* account, which we have before found to fall on the 12th March 1822. The consequence would also be, that the Sydereal month of Poongoni 4923 would count one day more than the Civil one; and that all the Civil dates in the said month would be one day in advance of the Sydereal account, which is not the case in the present computation.

We have thus been obliged to suspend the computation of the mean Elements, from the necessity of fixing the date of the Luni-solar *Soota dina* according to the Solar Kalendars, without which it would be impossible to determine the circumstance of the intercalary and expunged Tidhis, in the Chandra Panchangum. We shall now resume it in the following Article.

ARTICLE 6.

THIRD OPERATION.

For the *Ravi Madhyama Graha* or mean place of the Sun in the Hindu Zodiac.

		ˢ	°	′	″	‴
(*)	$\frac{4320000 \times 714404094775}{1577917828}$ - -	11	9	26	36	37

FOURTH OPERATION.

For the *Chandra Madhyama Graha*, or mean place of the Moon

in Do.	$\frac{57753336 \times 714404094775}{1577917828}$ - -	11	21	15	34	24

FIFTH OPERATION.

For the place of the *Ravi Tunga Mandocha*, or Sun's Apogee

in Do.	$\frac{387 \times 714404094775}{1577917828000}$ - -	2	17	17	17	54

a Calpa.

(*) The form in which I present these expressions has been objected to as unauthorized by custom, for generally a quantity placed on the right side of an Equation of this sort, implies a remainder: but a different disposition of the figures would have perplexed the reader's eye, and the results when referred to are more readily found when classed in order after the expressions. Mr. Samuel Davis has followed the same notation without its being objected to in Europe, I rely on the same indulgence.

SIXTH OPERATION.

For the place of the *Chandra Mandocha* or Moon's Apogee in Do.

		s	°	′	″	‴
$\frac{488203\times714404094775}{1577917828}$	- - -	7	2	57	26	12
Correction of Bijah $\frac{4\times714404094775}{1577917828}$	- - - add	0	1	38	27	10
		7	4	35	53	22.

SEVENTH OPERATION.

For the Ayanansa or Ayana Bagahs. (*)

	Revolutions.	Parts.		s	°	′	″	‴
$\frac{600\times714404094775}{1577917828}$	(271650)	683742	or	8	6.	8	4	57

	s	°	′	″	‴
and	8	6	8	4	57
—	6				
	2	6	8	4	57
				×	3
10)	6	18	24	14	51(0 19 50 25 29

The Ayanansa on the 12th of Poongoni of the Solar year 4923 of the Cali yug, being the day of last Amavasya (conjunction) of the Luni-solar year of the same denomination, is therefore - - 0 19 50 25 29

(*) I cannot dismiss the operation for finding the *Ayanansa*, the most important Element of Hindu Astronomy, in as much as it is the Equation which transfers all the computations made on the Sydereal, to the Tropical Sphere, without offering a few words on the formula used in the text, and the view which modern European Scholiasts have taken of the theory of that Element, in which some differ very materially. All that the Surriah Siddhanta says on the Ayanansa, is comprised in the following few lines, in reporting which I use Mr. Davis's version.

" The Ayanansa moves Eastward thirty times twenty in each Maha yug. By that number (600) multiply the " *Ahargana*, and divide the product by the number of Savan days in a yug, and of the quotient take the *Bhuja* " (supplement to or excess over 180°), which multiply by 3, and divide the product by 10; the quotient is the " Ayanansa. With the Ayanansa correct the *Graha*, *Cranti*, the *Ch'haya*, *Charadala* and other requisites to find " the *Pushti* and the two *Vishuvas*.

" When the *Curna* (Hypothenuse) is LESS than the *Surriah Ch'hya* (the Gnomonic Shadow of the Sun) the *Prac-* " *Chacra*, moves Eastward, and the Ayanansa must be added; and when MORE, it moves Westward, and the " Ayanansa must be subtracted."

The commentary goes on to say, "that if the Sun's true place (Sputa Graha) computed by the *Ahargana*, be " *less* than that found by his Gnomonic Shadow, the Ayanansa must be added (and vice versa). In present times " (adds the Tika) the Ayanansa is added."

From the above passages the modern Hindu Sastras (and Mr. Davis after them) conclude, that the Equinoctial points are considered in the Surriah Siddhanta, as *librating* from the 3d degree of Min ♓, to the 27th of Mesha ♈;

NOTE.—Since the Equinoctial points complete their revolutions 600 times in a Maha yug, and during each, pass through a space equal to four times 27°, or 108° of the Ecliptic, which is 3-10ths of 360°, (its whole circumference) the remainder, of the preceding operation, after subtracting the *Bhuja*, is drawn into $\frac{3}{10}$. Now for the annual variation, we have according to former Precepts $\frac{600\times3}{4320000\times10} = \frac{1}{24000}$ revolutions, equal to 54″ exactly. Hence, for finding the Ayanansa at any particular time, the Sastra rule may be dispensed with; for it needs only b remembered that the fixed and moveable Solar Zodiac, are supposed to have been coincident at the expiration of the 3600th year of the Cali yug; and that the Equinoctial points have a retrograde motion of 54″ in a Sydereal year. Therefore, to find the Ayanansa for the end of the Solar year of the Cali yug 4923, we have 4923—3600=1323, and 1323×54″=19° 50′ 42″.—This result differs from that found by the 7th Operation by 17″ 31‴, but the latter was for the end of the *Luni-solar* and not the *Solar* year 4923, which began 19 days later. True it is, that this difference accounts only for 2″,8; but the Tellinga Astronomers are contented to use the *Druva* or Epoch of the year 3600 of the Cali yug for common computations, because they generally neglect the seconds. One thing is certain, however, which is, that if at the end of the said Solar Sydereal year there was truly no Ayanansa (as they suppose), their method is more secure than that of the Sastras. The Table XXXV of this collection has been constructed with reference to the *Druva*.

For the period in time of the revolution of the Ayanas we shall observe, that as there are 600 *Baghanas* (for so they are called in the *Varasanhita)* in a Maha yug and of Saura years in the same period 4320000, it follows that one Baghana of the Ayanansa is equal to 7200 years. The Hindus divide that period into four quarters, called *Padahs*, during the first and fourth of which

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and from the 3d degree of *Canya* ♍, to the 27th of Tula ♎, of the fixed Indian Ecliptic; for it must not be imagined that this conclusion originated with the gentleman above quoted; the same having been distinctly explained to me in Madras by the College Sastra (an able and aged Native Astronomer) in the year 1814, which is more than 25 years after Mr. Davis had written his tract.

The exact meaning of the word *Prac-Chacra* used in the Sungscrete text, is not sufficiently known to me to draw any satisfactory conclusion therefrom; but the term *Chacra* clearly means a *wheel* or circle, and if in the present case it may be taken in the sense of an Epicycle, it would not be a forced inference to consider it as one of a Radius equal to 27° of the Deferent, whose center would lie at the Equinoctial point, revolving on itself, and through which the line of *Rishis* (that which is supposed to pass through the center of the great Orb, and to be directed towards certain Stars of the great Bear; and at which the *four* fixed and moveable *Solar* and *Lunar* Zodiacs coincide after certain revolutions of time) should pass, in the plane of the Ecliptic. If such a scheme could be admitted, it would not be difficult to comprehend how a point in the Axis of the moveable Orbit, revolving in the Epicycle and proceeding from the point of coincidence towards the East, might after 1800 years (one Padah, or quarter of the Ayanansa) reach its greatest Eastern Elongation, equal to 27° of the Deferent, then seem to move during 1800 years more in *antecedentia*, after which it would again fall in the line of the Rishis, in a point of superior conjunction when the Ayanansa would again be equal to Zero; from which, after passing through its greatest *Western* Elongation, it would proceed in consequentia, and in a complete period of 4×1800, or the *Cranti-Pata Gati* is additive, and consequently the Ayanansa is increasing, and during the second and third decreasing.

The obliquity of the Ecliptic is supposed to be constantly 24°; and it must be a matter of astonishment to perceive, that those who were able to discover (though imperfectly) the precessional variation, should not have even suspected the diminution of the former.

There remains now to explain the word *Bhuja*, which was used for the first time in the last Operation; but of which we shall make frequent use in the sequel.

The *Bhuja* is always understood to be the supplement of an arc of 6 or 12 signs, or the difference above 6 signs, and below 12 signs, if the arc exceeds 6 or 9 signs; thus:

1. If the arc exceeds 3 signs - Subtract from 6 signs.
2. If it exceeds 6 signs - - Retrench 6 signs from the arc.
3. If it exceeds 9 signs - - Subtract the arc from 12 signs.

All Hindu Tables and Rules are adapted to these Rules.

The mean Elements being thus computed, they are, when collected in one view for reference, as follows:

		s	°	′	″	‴
Sun's mean place 12th Poongoni 4923		11	9	26	36	37
Moon's Do.	Do.	11	21	15	34	24
Sun's Apogee	Do.	2	17	17	17	54
Moon's Do.	Do.	7	4	35	53	22
Ayanansa	Do.	0	19	50	25	29
Obliquity of the Ecliptic		0	24	0	0	0

We shall now pass to the computation of the true, or *Sputa* Elements.

7200 years from the outset, and after having revolved through an arc equal to 108 degrees of the Deferent (360 of the Epicycle) return to its original point of coincidence.

A similar notion occurred to the Arabian Astronomer Tebith-Ben-Chora in the IXth century, when he attempted to account for the change in the obliquity of the Ecliptic (unknown to the Indians, who always take it to be 24°) and the inequality of the precessional variation. He supposed an Epicycle at the Equinoctial point and found with reference to it that the Stars sometimes appeared to move *towards the East* and at others *towards the West*, with unequal velocities; that doctrine was victoriously combated by Rheinholdus and Regiomontanus; nevertheless, by an hypothesis much ressembling it, it so happens that the small quantities of the Nutation of the Earth's Axis, have been resolved by our own Astronomers during the last century.

But what leads me to abandon this hypothesis, is, that I perceive no where in the Hindu doctrines, any trace of a variable motion in the Equinoctial points, which, whether the *Cranti Pata Gati* (literally the motion of the Nodes of the Ecliptic) be considered as a libration or a revolution, should be felt particularly, either at the limits, or the Eastern and Western Elongations; such a notion being especially inseparable from that of an Epicycle. Nor can it be ascribed to ignorance on the part of the Hindus, who have shewn themselves to be fully aware of the effect above adverted to in their theory of the Anomalistic Equation, where they increase or decrease the Radius of their Epicycle, as it is supposed to approach or recede from the Sizigies, and take their *Paridhi*-ansas (Epicycular degrees) equal to Zero, between *Sama* and *Vishama* (odd and even), i. e. at 3 and 9 signs Anomaly.

ARTICLE 7.

For the true Elements and the Amavasya and Prathama Tithi of the year Cali yug 4923.

In eliciting the *true* Elements I shall follow the course of the Southern Hindu Astronomers in their various contrivances for saving as much labour as possible, consistently with correct deductions. Several of these methods are new to Europeans.

EIGHTH OPERATION.

For the Sun's true place in the Hindu Zodiac, or Sputa Graha.

The Sun's true place.

	•	•	′	″
Subtract the ⊙'s Madhyama Graha - -	11	9	26	37
From the place of his Apogee (Mandocha) -	2	17	17	18
Manda Kendra or Argument of Anomaly, -	3	7	50	41
From which subtract - - -	6	0	0	0
Bhujah or supplement - - -	2	22	[9	19

or 82° 9′ 19″ = 559″

With 82° refer to Maracanda Anomalistic Table (Ravi P'hala, Table XXV.)

take for 82°	2°	9′	18″
83	2	9	36
And for the remaining 9′ 19″			18

Vicala. Cast.

Say 60 : 559 :: 18 : $\frac{559\times18}{60} = 2\quad 47$

which last fractional part 47‴ exceeding 30″, merge into the vicalas and take 3.

Equation for 82° - - - -	2	9	18
Fractional part - - - -			3
Manda P'hala or Anomalistic Equation - -	2	9	21

Now this Equation (*) being additive for midnight, the apparent time, or instant of the Sun being actually on the other Meridian, must be somewhat later than the mean time of midnight, or when his mean place answers to the Meridian. The Equation due thereto (which always depends on the Sun's Anomalistic Equation) is what the Hindus call *Arca-Bahoota Sumscara*, or *Arca Bhagábala*: for the correct resolution of which

Arca-Bahoota Sumscara or Bhagá'bala.

(*) Mr. Davis having demonstrated that Maracanda's Tables were constructed by help of the Trigonometrical Tables of which he has investigated the theory, it would be useless for me to prolong this paper by using the Pindas instead of the Equations. Those, however, who may be desirous to practise the long process, will find in Table XXXI a canon of sines, cosines, and versed sines, which has not yet appeared in print.

Say	360° the revolution through the diurnal Circle or	1296000″
	59′ 8″ Sun's mean motion in 1 day -	3548
	So Equation due to 82° (2° 9′ 21″) -	7758

$\frac{3548 \times 7758}{1296000} = 21''$ The Arca Bhagábala. (*)

Sun's mean Longitude -	11ˢ	9°	26′	37″
Manda P'hala - -		2	9	21
Arca Bhagábala - -				21
Sun's Sputa Graha, or true place for apparent midnight at Lanca -	11	11	36	19

Ninth Operation.

For the Sun's true motion or Sputa Gati.

The Sun's true motion.

The Sun's mean motion in one day being 59cal 8vic, with the Bhujah of Manda Kendra found before 82° 9′ 17″ (8th Operation), referring to Table ~~V~~ XXIV, in the column of difference from mean to true motion, you find 18″; and as the difference for one degree is only 3″, the quantity due to 19′ 17″ may be neglected.

Table I. ☉'s mean motion in one day - -	59′	8″
	+	18
Sun's Sputa Gati 12th Poongoni - - -	59	26

Tenth Operation.

For the Moon's true place, or Sputa Graha.

The Moon's true place.

From the place of the Moon's Apogee - -	7ˢ	4°	36′	53″
Subtract her Madhyama Graha - -	11	21	15	34
Chandra Manda Kendra or Argument of Anomaly -	7	13	20	19
From which retrench - - -	6	0	0	0
Bhujah, or distance from Perigee - -	1	13	20	19
	or	43	[20	19=1219″

With 43°, referring to Table XXV, you find

for 43° —	3°	27′	26″
44 +	3	30	54
Difference	3	28=	208″

Then say : 60 : 208″ :: 1219″ : $\frac{208'' \times 1219}{60} = 1' \ 10'' \ 25'''$

and for second difference

: 360° : 208″ :: 3° 27′ 26″ : $\frac{208'' \times 12446}{360}$ = 19 vicalas.
12446″

(*) In order to save the trouble of these computations, the Hindus generally take the Sun's Arca Bhaga'hala to be the 365th part of its Anomalistic Equation: thus $\frac{2\ 9\ 21}{365} = 21''$, and the Moon's $\frac{2\ 9\ 21}{27} = 4' \ 47''$, difference 4″.

Hence, Equation for 43°	3°	27′	26″
1st Equation		1	10
2d do.			19
Manda P'hala or Anomalistic Equation subtractive	3	28	55 —

For the Arca Bhagábala or Equation of the Moon's place from mean to true midnight, say : as 360° : to 2° 9′ 21″ (Sun's Manda P'hala, 8th Operation) :: 13° 10′ 35″ (Moon's mean motion in one day, 11th Operation) :

: $\frac{2^\circ\ 9'\ 21''\times 13^\circ\ 10'\ 35''}{360^\circ} = 4'\ 43''$ the Arca Bahoota Sumscara, depending on the Sun's Anomalistic Equation, from mean to true midnight on the 12th of Poongoni, additive.

Thus we have

☽'s Madhyama Graha	11ˢ	21°	15′	34″
Manda P'hala subt. —		3	28	55
	11	17	46	39
Arca Bhagábala +			4	43
Moon's Sputa Graha or true place at apparent midnight on the 12th of Poongoni at Lanca	11	17	51	22

ELEVENTH OPERATION.

For the Moon's true motion or Sputa Gati.

The Moon's true motion.

The Moon's mean motion in one day is 13° 10′ 35″ : and her distance from Perigee is 1ˢ 13° 20′ 19″ (10th Operation) or 43° 20′ 19″.

With 43° referring to Table XXV, you find

For 43°	50′	48″
44	49	46
Difference	1	2

Then say ; 60′ : 20′ 19″ :: 62″ : $\frac{20'\ 19''\times 62}{60} = 30''\ 39'''$ or 31″.

We have therefore ☽'s mean motion in one day	13°	10′	35″
Equation for 43°		50	48
Proportional part			31
Moon's Sputa Gati or true motion on the 12th of Poongoni	14	1	54

TWELFTH OPERATION.

For the true distance and relative motion or Vi-Arca Indoo Graha and Gati.

True distance and relative motion.

☉'s Sputa Graha	11ˢ	11°	36′	19″
☽'s Do. Do.	11	17	51	22
Soob-vi-Arca Indoo Graha, or distance at midnight the Moon having passed the Sun.		6	15	3

		′	″
☉'s Sputa Gati		59	26
☽'s Do. Do.	14	1	54
Soob-vi-Arca Indoo Gati, or relative motion	13	2	28

which relative motion is the Element of the Sputa Tidhi; or true Luni-solar day due to the 12th Poongoni 4923.

THIRTEENTH OPERATION.

For the time due to distance or instant of Arca-Indoo Sangama.

Arca-Indoo Sangama, or Durcham. True conjunction.

The true distance of Sun and Moon at midnight of the 12th of Poongoni complete, or 13th commencing, according to astronomical reckoning was (preceding article) 6° 15′ 3″, and the relative motion 13° 2′ 28″, say therefore : $13^\circ\ 2'\ 28'' : 60^g :: 6^\circ\ 15'\ 3'' : \frac{60 \times 6^\circ\ 15'\ 3''}{13^\circ\ 2'\ 28''} =$

The time sought $= 28^g\ 45^v\ 32^p$.

But the Moon had passed the Sun when it was true midnight at Lanca, and the notation of the Tidhi requires the knowledge of its juxta position to Sun rise (Art. 2, paras. 9, 10 and 14); therefore to express the time of conjunction in Solar time where midnight falls on the 45th guddia,

	45		
Subtract therefrom time due to distance	28	45	32
True Amavasya after Sun rise of the 12th Poongoni *current*	16	14	28

which marks the instant when the last or *Pavarnami* Tidhi of the Luni-solar month Phalguna *ended*, and the *Prathama* Tidhi of the ensuing Chaitra *began*.

Notation of the Tidhi in the Panchangum.

Notation of the Tidhi in the Panchangum.

We have seen, Article 2, para. 10, page 72, that if a Tidhi happens to commence *after Sun rise* it is accounted to belong, not to its proper concurrent Solar day, but to the following one; therefore, although the present Tidhi was almost entirely spent in the 12th of Poongoni, yet it is to be coupled with the 13*th*, and so it will be found in the Patra for the Luni-solar year Cali yugam 4923, because the Solar month Poongoni having begun before Sun set, i. e. at $23^g\ 17^v\ 4^p$ (vide Kalendar) the Civil and Sydereal accounts coincide during the whole month.

ARTICLE 8.

Hindu Gnomonics.

All the foregoing resolutions are confined to the Geographical position of Lanca, which is supposed to have neither Latitude nor Longitude, a primary process which in all cases is indispensable when using the Rules of the Surriah Siddhanta. The object of the present article is, to shew what those results would be at any other place not under the Equator and first Meridian; and for this purpose the Hindus have recourse to the Tropical or moveable Sphere, supposed by some to be that of their primitive Astronomy.

Considering of what importance the theory of Gnomonics is to Hindu Astronomy, it is surprising that so little should have been written upon it by European commentators; for although Mr. Davis has resolved some of its Problems with his usual sagacity, yet he has gone no farther than his own immediate purposes required. In order to fill this chasm in our present stock of information, I have collected in this article every case that appeared to me of importance; but if I have omitted any, the ingenious reader will easily supply the deficiency, by drawing Corollaries from those expounded in the Examples.

Although the present article professes to treat only of Gnomonics, yet I have found it expedient, for the sake of arrangement and expedition, to dispose along with what strictly relates thereto, of those Problems to which Gnomonics are auxiliaries.

The theory of these Problems rests of course, on Plane and Spherical Trigonometry, and every case expounded in the following pages is exclusively resolved on Hindu principles, and by help of Tables of their own, the formulæ of which will be found annexed to Table XXX of this collection.

An account of the terms used in Hindu Tropical Astronomy and Gnomonics being indispensable, the names of the principal Elements are defined and explained in the following list.

DEFINITIONS.

Sanku, or Sunka—The Gnomon.

Ch'hya or Chaya—Its Shadow.

Palabah, or Vishama Chaya—The Shadow of the Gnomon at mid-day, when the Sun is in the Equinoctial points.

Vishama Carna—The Hypothenuse of a right angled triangle formed by the Sanku and the two sides of its Shadow under the preceding circumstances.

Madhyama Chaya—The mid-day Shadow at any other time of the year.

Sama-Mandala-Chaya—The Shadow when the Sun is East or West of the Gnomon.

Cranti Mandala—The Ecliptic.

Cranti Bagahs—The declination of a point of the Ecliptic.

Nari-Mandala—The Equator.

Sayana—Celestial Longitude considered in the same manner as that of the Europeans.

Vicshipa—Celestial Latitude.

Seva-desa-Paridhi—A circle of Longitude in any given Latitude.

Agra—The Amplitude.

Natansa, or Nata Bagha—Zenith distance.

Cshetija—The Horizon.

Lagna—The Arc of the Equator which passes over the Meridian in the same time with each Sign of the Ecliptic.

Madhyama Lagna—Mean Do. that of Lanca, the same Arc which rises above the horizon with each Sign of the Ecliptic.

Ullagna—The Lagna of any particular place, being the Arc of the Equator which rises above the horizon of that place, in the same time that each Sign of the Ecliptic rises.

Dinarda—Half the day.

Ratri Arda—Half the night.

Jya or Jaya—When connected with the name of any Element means its Sine.

Paramapa-Cramajaya—The Sine of the greatest declination of a Planet. As the Hindus take the obliquity of the Ecliptic to be constantly 24°, the above term when referred to the Sun, means the Sine of the obliquity.

Section I.

Description of the *Sanku* or Gnomon.

The Sanku is a strait Rod, Pole or Pillar of Stone, such as we invariably see placed in front of every Pagoda in India, placed perpendicularly on an horizontal plane. The Hindus trace a Meridional line by describing concentric circles from the point on which the center of the Pillar is to rest on the ground, precisely in the same manner as Europeans do.

Its construction.

Divisions.

Whatever be its height, the Sanku is divided into 12 angulas, or digits, and each angula is subdivided into 60 vinculas. It thus serves as a scale for measuring the Ch'hya or Chaya, the length of the Meridional shadow; and a Rod is accordingly made of the same dimensions and divisions for that purpose.

In marking alternately the points where the top of the shadow cuts any of the concentric circles, they chuse the time of 5, 6 and 7 dandas (or Indian hours of the *murta* account 60 to a day) before and after *noon: This being done the arcs are bissected; the Meridian line is traced*, and the four Dikas, or cardinal points; with the *Asta Dikas*, the four intermediate divisions are easily determined.

Dimensions of the Equatorial circle, and parallels of Latitude.

Before entering into the resolution of the Problems which depend on the length of the Meridian shadow, it is proper to enquire how the Hindus compute the dimensions of the Equatorial circle, and thence those of the parallels of Latitude of any given place.

Ratio of the diameter to the circumference.

Of their manner of resolving geometrically the ratio of the diameter to the circumference of a circle, I never saw any Indian demonstration: the common opinion, however is, that they approximate it in the manner of the ancients, by exhaustion; that is, by means of inscribed and circumscribed Polygons. However, a Native Astronomer who was a perfect stranger to European

Geometry, gave me the well known series $1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+\frac{1}{9}-\frac{1}{11}+\frac{1}{15}$ &c. to *unit* (*) being the ratio of the area of the Circle to the square of its diameter, or that of an Arc of 45° to Radius unit,—and $4\times(1-\frac{1}{3}+\frac{1}{5}$ &c.) equal to the circumference, the diameter being 1. This person reduced the five first terms of the series before me, which he called *Bagah-Anoobanda*, or *Bagah Apovacha;* to shew that he understood its use. This proves at least, that the Hindus are not ignorant of the doctrine of series; but I could not understand whether he pretended to make out his ratio of the Earth's diameter 1600 to Equatorial Circle 5059 (that which he used in all his computations) by means of these expressions.

Be this as it may, it is certain that according to their Trigonometrical Tables, the Radius, or Sine of 90° being equal to 57° 18′ (†), the diameter would be to the circumference as 1 : 3,14136, &c. (‡) so that dividing the diameter of the Earth into 1600 yojanas, it would give the Equatorial Circle 5026,176 yojanas. But it is somewhat singular to observe, that they should have preferred for constant use another ratio much less accurate, by their own account.

Dividing the diameter, as before stated, into 1600 parts, and multiplying the square of that number by 10, the root of the product $\sqrt{10\times\overline{1600}^{2}}=5059,6$ yojanas gives the dimensions of the Equatorial Circle. Or taking the ratio as $1:\sqrt{10}$, otherwise 1 : 3 . 1619, &c. they have the same 5059,04 yojanas.—In all calculations of the Hindus that I have seen, they content themselves with using 5059yo, which is somewhat nearer to their Tabular ratio: but in the following calculations I have used the mean or 5059,3, which difference, however, is of little importance, considering the means that are used for determining the Palabah, the principal Element.

Practical Rule for finding the dimensions of the Equatorial Circle in yojanas.

Quantity used 5059,3 yojanas.

Sometimes when the Almanac makers pretend to be *very accurate*, they divide the diameter into 20,000 parts, and then using the above formula $\sqrt{10\times\overline{20,000}^{2}}$ they have 62832y for the

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(*) I owe the following Note to Mr. Hyne's favour. "The Hindus never invented this series; it was communicated with many others, by Europeans, to some learned Natives in modern times. Mr. Whish sent a list of the "various methods of demonstrating the ratio of the diameter and circumference of a Circle employed by the Hindus "to the Literary Society, being impressed with the notion that they were the inventors. I requested him to make "further inquiries, and his reply was, that he had reasons to believe them entirely modern and derived from Euro-"peans, observing that not one of those who used the Rules could demonstrate them. Indeed the pretensions of the "Hindus to such a knowledge of Geometry, is too ridiculous to deserve refutation." I join in substance in Mr. Hyne's opinion, but do not admit that the circumstance that none of the Sastras mentioned by Mr. Whish, who used these series could demonstrate them, would alone be conclusive. It cannot certainly be denied, that the inventors of the system of Hindu Astronomy possessed a knowledge of Geometry which their successors have not entirely preserved, and if we bring the question home to ourselves we are compelled to acknowledge, that thousands (even among the well informed) use La Place's formulæ without understanding the principles of their construction.

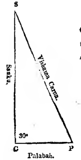
(+) The European Arc is =57° 14′ 24″,8.

(‡) Do, as 1 : 3 14159 &c.

dimensions of the Equatorial Circle: but all they gain is, that they exhibit the same ratio into minuter parts, without any nearer approach to truth.

The Palabah.

PROBLEM I.



Let SC be the height of the Gnomon, divided into 12 angulas, or 12×60=720 vinculas; CP the Palabah, or mid-day shadow at the Equinox. SP the Vishama Carna, or Hypothenuse of the Gnomonic shadow on the same day; and ∠CSP be the Polar Altitude; which in the present case let it be 13° 4′ N. Say:

As Cosine Polar Altitude CSP - - - -	3348′
To Sine of the same - - - - -	776′,2
. So height of the Sanku SC - - - - -	720 vinculas.
To $\frac{776'\,2\times720'}{3348}=$ - - - - -	166,8=2aug. 46,8 vin.

the length of the Palabah, or Equinoctial shadow at Madras: a constant quantity for that place.

Q. E. In.

The Acsha Bagahs or Latitude.

PROBLEM II.

	Angulas.	Vinculas.
Given the Palabah or Vishama Chya (above found) - - -	2	46,8

Wanted the Acsha Bagahs, or the Altitude of the Pole?

A

To determine the length of the Vishama Carna, or Hypothenuse SP, the angle at C being a right one, we have

	Angulas.	Vinculas.
$\sqrt{720^2+\overline{2\,.\,46,8}^2}=$ - - -	12	9

B

Then: As Vishama Carna - - - -	12	9
To Palabah - - - - -	2	46,8
So Radius - - - - - -	3438′	
To - - - $\frac{12\,.\,46,8\times3488}{12\,.\,9}=$ -	776′	

the Sine of the Acsha Bagahs, the same as found by the Tables in the preceding Example, whose Arc is 13° 4′.

COROLLARY.

Should the Altitude of the Equator or angle CPS be required, the proportion would be, As Vishama Carna SP, to height of Sanku SC, so Radius, to Lumbajaya; properly the Cosine of the Latitude of a place, but called in this place the Sine of the Altitude of the Equator, which using the same quantities as above, would be 76° 56′.

PROBLEM III.

Sera-desa-Paridhi, or circumference of the Parallel Circle to the Equator.

Given the Altitude of the Pole - - 13° 4'
Whose Cosine is (Prob. I.) - - - 3348'
The circumference of the Equatorial Circle (page 93) - - 5059,3 yojanas.

Wanted the Parallel Circle of Longitude due to the above Latitude (that of Madras). Say

As Radius - - - - - - 3438'
Cosine Latitude - - - - - - - 3348'
So circumference of the Equatorial Circle - - - 5059,3 yo.
To - - $\frac{3348' \times 5059.3}{3438}$ - - - - - - - 4925,9 yo.

The Sera-desa-Paridhi, or circumference of the Circle of Longitude in the Latitude of Madras (that entered in Table XXXIV.) (*) Q. E. In.

PROBLEM IV.

Assignable Desentara in yojanas and in time.

Given the circumference of the Circle of Longitude in the proposed Latitude (Prob. III) - - - - - - - - 4925,9

The distance in degrees of the given place East or West from the first Meridian (Lanca) - - - - - - - 4° 35' E.

which in the present case let it be the Desentara of Madras. Wanted the Longitude in time and yojanas.

A

Say : as 360° : 5059,3 :: 4° 35' : $\frac{5059,3 \times 4° 35'}{360}$ = 64,4 yojanas.

N. B.—At Madras the Hindus take this assignable Desentara in round numbers to be 64 yojanas, which however, gives too strong a difference in time.

B

To convert this quantity into time, say : As circumference of the Circle of Longitude 4925,9 yo. : to a natural day, or 60 guddias :: :: so 64,4 yo. : $\frac{60g \times 64,4y}{4925,9}$ = 47 vig. 4 paras.

Q. E. In.

The time due to the difference of Meridians.

N. B.—If the degrees and minutes of Longitude be converted into time according to the European method, 4° 35' will give $45^v\ 57^v$; the Natives at Madras take it $46^v\ 47^p$ (†).

(*) In Table XXXIV will be found the Seva desa-Paridhi, or circumference of the Circle of Longitude in yojanas, and the mid-day Equinoctial shadow in angulas, of the principal places in India.

† Vide Table XXXI.

Problem V.

The Latitude found by means of the Palabah.

Given the Palabah of some unknown place, which let it be 3ª 30ᵛ. Wanted its Latitude, or Acsha Bagahs.

(N. B.—This proposition is but a repetition of Problem II, but is introduced here in reference to the commentary in the Appendix, whose Problems are all resolved for the Latitude and Longitude of Banda, near Masulipatam.)

A

The Vishama Carna, or Hypothenuse of the Equinoctial shadow will be determined, as in Problem II, by the formula.

$$\sqrt{\overline{12}^2 + \overline{3y\ 30}^2} = \overset{\text{Ang.}}{12}\quad \overset{\text{Vin.}}{30}$$

B

Then say, As Vishama Carna 12ª 30ᵛ : to Palabah 3ª 30ᵛ, so Radius, to Acshajya the Sine of Polar Altitude $\frac{3a\ 30 \times 3138}{12\ 30} = 962'$ corresponding to an Arc of 16° 15 the Latitude of Banda. Q. E. In.

Problem VI.

Given the Sun's declination - - - - 1° 11′ North.

The length of the *Madhyama* Chya, or mid-day shadow due to that declination, - - - - - 3ª 14ᵛ (*)

The Latitude and Zenith distance by means of the Palabah, and Sun's declination.

Wanted the *Acsha Bagahs* (Latitude) and *Natansa* (Zenith distance.)

A

Proceeding on the same principles as in Problem II, the *Madhyama Carna*, the Hypothenuse of Shadow due to 1° 11′ declination North, will be

$$\sqrt{\overline{12}^2 + \overline{3\ 14}^2} = 12^{a}\ 26^{v}$$

B

Then say

As Madhyama Carna, - - - 12ª 26ᵛ

To Chya or Shadow, - - - - 3 14

So Radius, - - - - - 3438′

To - - $\frac{3a\ 14v \times 3438}{12a\ 26v}$ = - - - 894′

The Zenith distance or Natansa.

The *Natajya*, or Sine of Zenith distance at noon, which corresponds to an Arc of 15° 4′.

C

The Acsha Bagahs or Latitude.

In the present case as the Sun at noon, is *South* of the Zenith, and as his declination is *North*,

---

(*) Vide Scholium for the manner of determining this quantity.

their sum 15° 4′ + 1° 11′ = 16° 15′, gives the Altitude of the Pole, as before determined. (Prob. V.)

SCHOLIUM.

When the Altitude of the Pole and the Sun's Declination are both given, the Madhyama Chaya or mid-day shadow for any day in the year may be found by reversing the foregoing rule.

PROBLEM VII.

Given the Sun's Zenith distance at noon	15° 4′ S.
The Altitude of the Pole	16 15 N.
The Palabah	3^{a} 30^{v}
The Vishama Carna or Hypothenuse	12 30

Wanted the difference between the Palabah and Madhyama Chaya on the day when such Zenith distance was observed at noon, and the Declination, or Cranti Bagahs.

Madhyama Chaya for any day in the year, and Declination or Cranti Bagahs.

A

The Zenith distance being South and the Latitude being North, take their difference.

Zenith distance	15° 4′ S.
Latitude	16 15 N.
Sun's Declination	1 11 N.

B

Then say

As Madhyama Cotijya, or Cosine of the Sun's Zenith distance at noon 15° 4′	3320′
To Vishama Carna 12^{a} 30^{v}	12^{a} 30^{v}
So Sine of Sun's Declination equal to its Arc 1° 11′	71′

: To $\frac{\overset{a.\ v.}{12\ 30} \times 71''}{3320} = 0^{a}\ 16^{v}$ which quantity subtracted from the Palabah 3^{a} 30^{v}

— 0 16

gives 3 14 the

Madhyama Chaya or mid-day shadow for the day on which the Zenith distance was observed.

Q. E. In.

PROBLEM VIII.

Given the Altitude of the Pole	16° 15′ N.
The Sun's Declination	1 11′ N.
The Palabah	3^{a} 30^{v}

Wanted the *Sama-Mandala Chaya*, or length of the shadow when the Sun is East or West.

Sama-Mandala Chaya.

A

Say : As Sine Declination 1° 11′	71′
To Sine of Latitude 16° 15′	962′

So height of Sanku 12° or 720′

To $\frac{962' \times 720'}{71'} =$ 162° 36″ the Sama-Mandala *Carna* or Hypothenuse of the Shadow. (*)

B

Lastly, the Sama-Mandala Carna being thus found to be 162° 36″; and the height of the Sanku being always 12° or 720″, we have $\sqrt{\overline{162.36}^2 - \overline{720}^2} =$ 162° 9′, the Sama-Mandala Chaya sought.

Q. E. In.

PROBLEM IX.

Given the Sun's Declination 1° 11′ N.

The Palabah 3° 30″

The Ghara or Ascentional difference. Wanted the Chara, or Ascentional difference.

A

Say first: As height of Sanku 12° 0″.

To the Palabah 3 30

So Sine of Sun's Declination 1° 11′ 71′

To $\frac{3.30 \times 71}{12^{\circ}} =$ 21′ the Cshetijya.

B

Then: As Cosine Sun's Declination 1° 11′ 3436′

To Cshetijya above found 21′

So Radius 3438′

To $\frac{21' \times 3438'}{3436} $ 21′

the Sine of the Ascentional difference sought, which does not differ sensibly from its Arc.

Q. E. In.

PROBLEM X.

Given the Altitude of the Pole 16° 15′

The Sun's Declination 1° 11′ N

Wanted the Sun's Altitude at 10 dandas before and after noon.

(*) SCHOLIUM,

The same result may be obtained by the following Canon:

As Sine of Declination 1° 11′ 71′

To Cosine of Latitude 16° 15′ 3290

So Palabah 3a 30v

To $\frac{3299' \times 3a.\ 30v.}{71'} =$ 162a 36v, the same as before.

PREPARATION.

Of 16° 15′ the Sine is 962′ Cosine 3299′
Of 1° 11′ ,, 71 ,, 3436
10 dandas answer to an Arc of 60° (*) whose Cosine is 1719′

A

Say As Cosine Latitude 3299′
To its Sine 962′
So Sine of Declination 71′
To $\frac{962' \times 71'}{3299} =$ 3′ Sine of the Cshetijya. (†)

B

As Cosine Declination 3436′
To Cshetijya 3′
So Radius 3438′
To $\frac{3 \times 3438}{3436}$ 3′ Sine of the Charajya.

C .

Add the Cosine of the Hour Angle to the Charajya 1719′
3′

You have the Wutrajya 1722′

D

Then say : As Radius 3438′
To the Wutrajya 1722′
So Cosine Declination 3436′
To $\frac{1722 \times 3436}{3438} =$ 1721′ the Chadam.

E.

As Radius 3438′
To the Chadam 1721′
So Cosine of Latitude 16° 15′ 3299′

(*) Table XXXI.

(†) The Hindus instead of saying: As the Cosine of the Latitude: to its Sine, always say: As the Sanku or Gnomon: To the Vishama Chaya, or Equinoctial Shadow, &c.

To the Yesta Sanku (*)

$$\frac{1721 \times 3299}{3438} = \text{ - - - - } 1652'$$

or Sine of the Sun's Altitude, whose Arc is 28° 45′ at 10 dandas before and after noon.

Q. E. I.

PROBLEM XI.

Given the Altitude of the Pole	16°	15′
The Sun's Declination	1	11 N
The Sun's Altitude	28	45

The time before or after noon.

Wanted the time before or after noon.

N. B.—The present proposition is only the converse of the preceding one.

A

Say: as Cosine Latitude: Sine Sun's Altitude :: So Radius: to the Chadam

$$\frac{1652 \times 3438}{3299} = 1721'$$

B.

As Cosine Declination: to the Chadam :: So Radius: to the Wutrajya.

$$\frac{1721 \times 3438}{3436} = 1722'$$

C

As Cosine Latitude: to Sine of the same :: So Sine of Sun's Declination: to the Cshetijya.

$$\frac{962 \times 71}{3299} = 3'$$

D

As Cosine Declination: *to the* Cshetijya :: So Radius: to the Charajya.

$$\frac{3 \times 3438}{3436} = 3'$$

E

The Wutrajya (B) minus the Charajya (D) gives the Cosine of the Hour Angle from noon, i. e. 1722′—3′=1719′; the Arc answering to which is 60°; and this Arc answers to 10 dandas (+.)

Q. E. In.

(*) The Sine of the Sun's Altitude being called the Yesta, its Cosine is termed the Yesta Drŏg Jya; which explains the following analogy.

As Yesta Drog Jya
To Yesta
So Yesta Chaya or length of Shadow
To height of the Sanku

whose Hypothenuse is sometimes called *Yesta Carna.*

(+) Table XXXI.

NOTE.

1° By help of the preceding Problems if the Altitude of the Pole be given, the *Ravi Sayana*, or Sun's Longitude reckoned from the Equinoctial point may be found from day to day, by means of the Madhyama Chaya or Meridian shadow.

2° The length of the shadow being known (Problem VI), the Sun's Zenith distance may be found.

3° The Meridian Zenith distance, and the Latitude of the place being known, the Sun's Declination may be found (Problem VII.)

4° The Obliquity of the Ecliptic being always 24°, and the Sun's Declination being given, the Hypothenuse or Arc of the Ecliptic between the Sun and Equinoctial points, called the *Ravi Sayana*, is easily found.

SECTION II.

The length of the Bhumi Savan day.

In order to determine the length of the Savan day, or the true time from Sun rise to Sun rise, in Sydereal time for every day in the year, we must establish : 1° What the Sun's Declination is when his Longitude (*Ravi Sayana*) is I^s; II^s; and III^s.—2° The *Lagna*, or its Right Ascension when his Longitude is in the said points of the Ecliptic.—3° The *Agra* or Amplitude of the Sun under the same circumstances.—4° The *Chara* or Ascensional difference under do.—5° The *Ullagna*, or Oblique Ascension of each Sign of Longitude counted from the Equinoctial points, for the particular Latitude which is to be computed for.

1°

Sun's Declination, 1st, 2d and 3d Signs.

To find the Sun's Declination when his Longitude is I^s; II^s and III^s.

DATA.

Obliquity of the Ecliptic (constant)	24°
Its Sine, or *Paramapa-Cramajya*	1397′
Cosine do.	3140′
The Sine of 30° or I^s the Yekajya . . .	1719′
of 60 II the Duojaya . . .	2978′
of 90 III the Trijaya . . .	3438′

N. B.—In order to save useless repetitions, it is to be understood that any expression given thus $\frac{1719' \times 1397'}{3438} = 698'$ implies the *Trirasica* and means : As Radius 3438 : to Sine 30° 1719 :: So is Sine Obliquity 1397′ : to 698′ the Sine of the Declination sought, which in the present case answers to an Arc of 11° 43′, whose Cosine is - - 3366′ the Declination due to I Sign or 30°.

$\frac{2978' \times 1397}{3438} = \begin{matrix} 1211' \\ 20° 38' \end{matrix}$ the Sine of the Declination due to II Sign or 60°.

And for the III^s or 90° the greatest Declination being 24° its Sine is - 1397′

And Cosine - - - - - 3140

Signs	DECLINATION.	Sines.
I	11° 43′	698′
II	20 38	1211
III	24 0	1397

2°.

To find the Lagna or Right Ascension under the foregoing circumstances.

FORMULA.

Sun's Right Ascension, 1st, 2d, and 3d Signs.

As Cosine of Declination
To Cosine Obliquity of Ecliptic
So Sine Yekajaya, Duojaya, &c. or Longitude I, II or III^s
To Sine of Right Ascension.

For I Sign.

$$\frac{3140' \times 1719'}{3366'} = 1604' \text{ the Sine of the Right}$$

Ascension, whose Arc is - - - - 27° 50′

For II Signs.

$$\frac{3140 \times 2978}{3366} = 2907'$$

the Sine of Right Ascension, whose Arc is - - 57° 45′

For III Signs.

We have of course 3438 (equal to Radius) - - 90°

Hence, Lagna calas, or minutes of the Equator answering to each Sign respectively.

$$\text{Signs}\left.\begin{array}{c} \text{I} \\ \text{II} \\ \text{III} \end{array}\right\} \text{- - - - - -} \left\{\begin{array}{l} 1670' = 27°\ 50' \\ 1795 = \overline{57\ \ 45} - \overline{27°\ 50'} \\ 1935 = 90 - \overline{57\ \ 45} \end{array}\right.$$

3°.

Sun's Agra, or Amplitude for Do.

For the Sun's Agra, or Amplitude, under the same circumstances.

FORMULA.

As Cosine of Pole's Altitude - - - - (13° 4′ Madras)
To Sine of Sun's Declination A. - - - 1°
So Radius - - - - - 3438′
To Agrajya or Sine of Amplitude.

For I Sign.

$$\frac{698' \times 3438'}{3348} = 716' \text{ the Sine of the Sun's}$$

Amplitude, whose Arc is - - - - - 12° 1′

For II Signs.

$\frac{1211 \times 3488}{3348} = 1243'$ the Sine of Amplitude, whose Arc is - - - - - 21° 12′

For III Signs.

$\frac{1397 \times 3488}{3348} = 1434'$ the Sine of Amplitude, whose Arc is - - - - - 24° 40′

Hence, the following Sun's Agras.

Signs				Sines.
I	- - - - - -	12° 1′	-	716′
II		21 12	-	1243
III		24 40	-	1434

3°

Sun's Chara or Ascensional difference for Do.

To find the Chara, or Ascensional difference, under the same circumstances.

FORMULA.

As Cosine Declination (Art. I)

To Sine of Pole's Altitude (13° 4′)

So Sine of Agra (Art. 3)

To Sine of Chara, or Ascensional difference.

For I Sign.

$\frac{716' \times 776 . 2'}{3366} = 165'$ the Sine of Chara, whose Arc is - - - - - 2° 45′

For II Signs.

$\frac{1243' \times 776 . 2}{3366} = 286'$ the Sine of Chara, whose Arc is - - - - - 4° 46′

For III Signs.

$\frac{1434 \times 776 . 2}{3366} = 331$ the Sine of Chara, whose Arc is - - - - - 5° 31′

Hence, the Calas or minutes of the respective Ascensional differences are,

Signs			Calas.
I	Prathama Chara Cumda	$\underline{2° 45'}$ =	165′
II	Madhya Chara Cumda	4° 46′ — 2° 45′ =	121′
III	Antera Chara Cumda	5° 31′ — 4 46° =	45′

4°

The Ullagna or Oblique Ascension.

To find the Ullagna, or Oblique Ascension of each Sign of Longitude for any particular place, which let it be Madras.

Subtract the Chara Cumda from the Lagna, in the *First* and *Fourth* Quadrant of Longitude; add it in the *Second* and *Third* Quadrants.

	— 1st and 4th Quadrants.			+ 2d and 3d Quadrants.		
	1^s or XII.	II or XI.	III or X.	IV or IX	V or VIII.	VI or VII.
Lagna	1670	1795	1935	1935	1795	1670
Chara Cumda	165	121	45	45	121	165
Ullagna	1505	1674	1890	1980	1916	1835

Such is the *Ullagna* of Madras, which, together with the Altitude of the Pole 13° 4′ and the Palabah 2 angulas, 47 vinculas, exhibit constant quantities for calculating the duration of the artificial and natural day throughout the year. Every Indian Astronomer, or Almanac maker, generally calculates a Table of this sort for the place where he resides.

5°

Diurnal motion in Oblique Ascension and length of natural day.

For the Sun's diurnal motion in Oblique Ascension.

A

The Sun's true diurnal motion on the day commencing the Luni-solar year Cali yugam 4924 was 59′ 26″, and his true place (Sputa Graha) in the Hindu Ecliptic - 11^s 11° 36′ 19″ (*)

The Ayanansa for Do. - - - - 19 50 25

Ravi Sayana or true Longitude - - - 0 1 26 44 (†)

So that the Sun is in the first Sign.

B

Calas.

Say then: As 30° (I Sign), or in calas - - - - 1800

To the Ullagna of the 1st Sign - - - 1505

So Sun's true diurnal motion in the Ecliptic on the given day - 59′ 26″

To $\frac{1505' \times 59' 26''}{1800'} =$ - - - - - 49′ 41″

The Arc of the Equator which rises above the Horizon *in the same time*, being the Sun's diurnal motion in Oblique Ascension on the given day.

C

For the length of the Savan day.

As the natural day of 60 dandas (according to the Murta denomination) contains 21600 pranacalas or respirations, which is the same number as there are of calas (minutes) in 360°, the

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(*) Vide computation of Elements.

(†) In the present case the Booja is not required.

circumference of the Equator; the above motion $49^{cal.}$ $41^{vic.}$ in Oblique Ascension may be considered as pranacalas, which therefore dividing by 6, gives $8^{vic.}$ $1,6^{pra.}$ (*)

The length of the Savan day from Sun rise to Sun rise is, therefore,

Dandas.	Vicalas.	Pranacalas.	
60	8	1,6	Sydereal time.

6o

Length of artificial day.

To find the length of the artificial day, or time of the Sun being above the Horizon.

A

We have found in the preceding article that the length of the Bhumi Savan day on which the Luni-solar year Cali yugam begun, was 60^{d} 8^{v} $1,6^{p}$, Sydereal time, one fourth part of which is 15^{d} 2^{v} $0,4^{p}$, or 15^{g} 2^{v} 4^{p}.

B

For the Sun's Declination on the same day.

Given the Sun's Ravi Sayana	0ˢ 1° 26′ 44″
Whose Sine is	87′
Obliquity of Ecliptic 24° and Paramapa-Cramajya	1397′
Say: As Radius	3438′
To Sine Ravi Sayana	87′
So Paramapa-Cramajya	1397′
(Sine of Obliquity)	
To Crantijya $\frac{87' \times 1397'}{3438} =$	35′

the Sine of the Declination sought, equal to its Arc.

C

For the Sun's Chara, or Ascensional difference.

1o

		Sine.	Cosine.
Data—The Pole's Altitude	13° 4′	777′	3348′
Sun's Declination N.	35′	35′	3137′

Say: As Cosine Polar Altitude	3348′
To Sine of the same	777′
So Sine of Sun's Declination	35′
To $\frac{777' \times 35'}{3348'} =$	8′

the Cshetijya; which gives only a first approximation.

(*) To convert the 49 calas, 41 vicalas (in degrees) into time, we have for the calas $\frac{49}{6} =$ 8v 1p, and 60 : 41 :: 10 : 6. Hence the time would be 8v 1,6p.

2°.

As Cosine Sun's Declination	3437′
To Cshetijya	8′
So Radius	3438′
To $\frac{8' \times 3438}{3437} =$	7′

the Charajya, or Sine of the Ascensional difference sought.

Hence the Sun's Chara on the first day of the year Cali yug 4923 was 7′, which corresponds to 1 vig. 10 paras of time nearly. (*)

D.

For the Dinarda, and Ratri Arda.

Because the Sun's Declination is North—To the 4th part of the Savan

	day (A)	15^{g}	2^{v}	4^{p}
	Add the time of the Chara (C) +		1	10
Half the day.	Dinarda, or half the day	15	3	14
	And	15	2	4
	—		1	10
Half the night.	Ratri Arda, or half the night	15	0	54

CONCLUSION.

The day. The artificial day, or Bhumi Savan dina, which opened the Luni-solar year Cali yugam 4923, was, therefore,

	$2 \times 15^{g}\ 3^{v}\ 14^{p} =$	30^{g}	6^{v}	28^{p}
The night,	And the artificial night $2 \times 15^{g}\ 0^{v}\ 54^{p} =$	30	1	48

COROLLARY.

	Hence if from $60+15^{g} =$	75^{g}		
	We subtract the Dinarda	15	3	14
Time of Sun rising.	Time of Sun rising at Madras on the given day,	59	56	46
	And if we add thereto the duration of the artificial day	30	6	28
Time of Sun setting.	The time of Sun setting on the same day, $(90^{g}-60^{g}) =$	30	3	14

It will be readily perceived that these resolutions differ materially from those procured by European Astronomy, which is to be particularly ascribed to the defective Longitude assigned to the Sun in the Indian Calculus.

(*) Table XXXI.

ARTICLE 9.

Having thus expounded the doctrine of Hindu Gnomonics, we are now to apply it to the reduction of the end of the Amavasya Tidhi calculated for Lanca in the preceding article, to any other Meridian or Latitude; and I shall select for that purpose, those of Madras, its *Acsha Bagahs* being $13^{\circ}\ 4'$, *Desentara* in time $47^{v}\ 4^{p}$ East of Lanca: and *Palabah* $2^{a}\ 46,8^{v}$.

For this we are to correct the Sun and Moon's Sputa Graha, or true places in the Indian Zodiac, as found at page 88, for midnight at Lanca, to what they were when it was midnight at Madras.

Reduction of the end of the Amavasya Tidhi at Lanca to any Meridian or Latitude.

DATA.

☉'s Sputa Graha at true midnight at Lanca on the 12th Poongoni -	11^{s}	11°	$36'$	$19''$
☉'s ,, Gati or true motion - - - -			59	26
☽'s Sputa Graha on Do. - - - - -	11	17	51	22
☽'s Do. Gati - - - - - -		14	1	54
Desentara in time - - - - - -			47^{v}	4^{p}
Acsha Bagahs - - - - - -			13°	$4'$
Relative motion - - - - - -		13°	$2'$	$28''$

12th of Poongoni at true midnight at Lanca.
Time complete.

A.

For the Sun's place on the 12th Poongoni 4923, reduced to the Meridian of Madras.

Say : 60 guddias : $59'\ 26''$ :: $47^{v}\ 4^{p}$: $\frac{59\ 26 \times 47\ 4}{60g} = 46''$, and as the Longitude of Madras lies East of Lanca, this quantity is *subtractive.*

Sun's true place at Lanca - - - -	11^{s}	11°	$36'$	$19''$
Subtract motion during $47^{v}\ 4^{p}$ - - - —				46
☉'s Sputa Graha on the same day at midnight at Madras -	11	11	35	33

B

For the Moon's place, reduced to the same Meridian.

The Moon's true motion on the given day was $14^{\circ}\ 1'\ 54''$, therefore say

: 60^{g} : $14^{\circ}\ 1'\ 54$ :: $47^{v}\ 4^{p}$: $\frac{14\ 1\ 54 \times 47\ 4}{60g} = 11'\ 0''$, being the Moon's progress in the given time, which, as the Moon was proceeding from the Sun, is *subtractive.*

☽'s Sputa Graha at Lanca - - - -	11^{s}	17°	$51'$	$22''$
Subtract —			11	0
Moon's Sputa Graha at midnight at Madras - -	11	17	40	22

C

For the Sun and Moon's true distance.

☉'s Sputa Graha - - - - -	11ˢ 11° 35′ 33″ (A)
☽'s Do. Do. - - - - -	11 17 40 22 (B)
Soob-vi-Arca Indoo Graha at Madras . . :	6 4 49

D

For the time due thereto, say

$: 13^{s}\ 2'\ 28''$ (Rel. mot.) $: 60^{g} :: 6^{\circ}\ 4'\ 49''$ (C) $\frac{60g \times 6^{\circ}\ 4'\ 49''}{13^{s}\ 2'\ 28''} = 27^{g}\ 58^{v}\ 27^{p}$

time before midnight when the conjunction occurred.

	G.	V.	P.
Therefore subtracting from mean midnight - -	45		
	27	58	27
Time of conjunction after *mean* Sun-rise at Madras on the 12th Poongoni, - - - - - -	17	1	33

E

For time after true Sun rise.

	G.	V.	P.	
We have found at Section II of Gnomonics (page 106), that the Sun rose on the 12th of Poongoni, at Madras, at - - -	59	56	46	
	60			
Equation of time - - - - - -	0	3	14	additive.
Time of conjunction after mean Sun-rise by present operations -	17	1	33	
End of Amavasya Tidhi - - - -	17	4	47	

True time of conjunction after Sun rise under the Meridian and Latitude of Madras.

or instant of conjunction after true Sun rising, being the end of the 30th, or Amavasya Tidhi of the Lunar month *Phalguna* of the 4923d year of the Cali yug, and the beginning of the *Prathama* or 1st Tidhi of Chaitra of the 4924th year current, under the Meridian and Latitude of Madras.

And as the said Prathama Tidhi began *after Sun rise* on the 12th Poongoni, it is to be coupled with the 13th of the said Solar month, as may be seen in the Skeleton of the Panchangum, page 67.

I shall close this article with a remark of Audi Sashaya Sastra.

Some of the Moon's Equations not considered in this process.

In the computation of Eclipses wherein the Elements must be rigidly computed, the Moon's place is subject to other Equations, which need not be considered in the construction of the common articles of the Panchangum, where the resolution of the end of the Tidhis, and disposition, and duration of the months and years, are principally considered. In the Solar or *Vakiam* process, of which a general account will be given in the second part of this Memoir, all the Equations which have been theoretically accounted for in the preceding articles, are computed by means of Tables where, in some cases, two or three are blended together, so as to be quite undistinguishable.

Thus for instance, what the Tamuls call the *Arca Bahoota phala*, *Desentara*, and *Beeja phala Sumscaras*, which are to account for the difference between mean and true time, of Longitude and Latitude, as these circumstances affect the Moon's place at a given instant and spot on the surface of the Earth, they compute together under the general designation of *Desentara Sumscara*, or Equation of Longitude, so that the vast majority of those who use these Tables and processes, are absolutely unable to give the least account of their construction.

How the Tamul Kalendar makers compute some of their Equations.

Whatever process is followed, however, these reductions are very long and tiresome. The preceding investigation of Hindu Gnomonics has enabled me to dispose rapidly of the latter part of the last Problem, but the reader will have perceived that, in order to reduce the end of a Tidhi, and consequently that of any month and year, from its time at Lanca to any other place arbitrarily proposed, requires more time than the utility of such a proposition deserves when it does not refer to some of the higher Astronomical Problems. In order not to fatigue uselessly his attention, I shall therefore dispense in future from carrying my computations further than Lanca, excepting in the last Example of all, where I propose giving an entire solution of the *Cshaya* or expunged month, which will occur in the 5065th year current of the Cali yug; answering to the 1886th from the birth of Salivahana, and to the Christian year 1963.

Article 10.

How to compute Seriatim *all the Tidhis in the year, the end of the last* Amavasya *Tidhi of the preceding year being given.*

The beginning of the 1st Tidhi in the year being computed, how to find all the rest.

We have been under the necessity of interrupting our progress in the construction of the Kalendar, for the sake of elucidating the various theories on which it is to be modified according to time and place: we shall now resume the original research, to show how the end of the successive Tidhis of the new year may be determined, from the resolution of the end of that which closed the preceding one.

We have seen that the Amavasya Tidhi which ended the year Cali yugam 4923, and commenced the 4924th, at Lanca, terminated after Sun rise on Poongoni 12th, (page 90) [15° 14' 28"

Add	1
	13th

to which date we are to adapt the Elements already obtained.

For the Sun's apparent place on the 13th Poongoni.

☉'s Madhyama Graha on the 12th, (page 87) - -		11ˢ	9°	26′	37″
☉'s mean motion in one day - - -	+			59	8
Madhyama Graha on the 13th - -		11	10	25	45
Place of Sun's *Mandocha* (Apogee) its motion insensible -	+	2	17	17	18
Ravi Manda Kendra - - -		3	6	51	33
		6			
Bhujah		2	23	8	27
Argument of Anomalistic Equation - - -			83°	[8′	27″
					507″

Proceeding as we have done before, we shall find the *Ravi Manda P'hala*			2°	9′	38″
And the *Arca Bhagábala*	$\frac{2^\circ\ 9'\ 38''}{365}$ (*)	+			22
			2	10	0
☉'s Madhyama Graha above found		11ˢ	10	25	45
Ravi Sputa Graha, 13th Poongoni,		11	12	35	45

For the Sun's true motion.

The Sun's apparent place.

Instead of deriving it as usual from the Tables, when computing *seriatim*, the Hindus take the difference of the Sun's Sputa Graha on the two successive days, because the increment or decrement of its Sputa Gati, (apparent motion) is comprehended in the Arca Bhagábala (page 83) as above applied (†).

The Sun's true motion.

We have consequently

Sputa Graha on the 12th Poongoni, (page 88)	11ˢ	11°	36′	19″
Do. Do. 13th do.	11	12	35	45
Ravi Sputa Gati, 13th Poongoni,			59	26

For the Moon's true place on the 13th Poongoni.

A

First correct the Moon's mean place.

☽'s Madhyama Graha, 12th Poongoni	11ˢ	21°	15′	34″
☽'s mean motion in one day		13	10	35
Madhyama Graha, 13th Poongoni	12	4	26	9

(‡) Arca Bhagábala depending on the Sun's Anomalistic

Equation	$\frac{2^\circ\ 9'\ 38''}{27}$	=			4	48
☽'s Corrected Graha, 13th Poongoni			0ˢ	4°	30′	57″

(*) The regular process for resolving the Arca Bhagábala would be

$$: 360^\circ : 59'\ 8'' :: 2^\circ\ 9'\ 38'' \text{ (Anom. Equat.) } \frac{59'\ 8''\times 2^\circ\ 9'\ 38}{360^\circ} = 22''$$

the same result as that used in the text. The two processes seldom vary by 1″. So that the short one may be used with all safety for general purposes.

(†) This explanation, as well as many others inserted in this work, were literally given to me by the Native Sastra whom I consulted on these operations.

(‡) The regular process would be

$$: 360^\circ : 13^\circ\ 10'\ 35'' :: 2^\circ\ 9'\ 38'' : \frac{13^\circ\ 10'\ 35''\times 2^\circ\ 9'\ 38''}{360} = 4'\ 43''.$$

B

For the place of the Moon's Apogee on the 13th Poongoni.

Place of *Mandocha* on the 12th Poongoni - -		7^{s}	4°	$35'$	$53''$
Motion of Do. in one day - -	+			6	41
Place of Mandocha on the 13th Poongoni - -		7	4	42	34
☽'s Corrected Graba (preceding article) -	—	0	4	30	57
Chandra Manda Kendra - - -		7 6	0	11	37
Argument of Anomalistic Equ. Bhujah - -		1	0	[11	37
			30	[11	37
					697″

C

Chandra P'hala Table for 30° - $2^{\circ}\ 32'\ 2$

31 - 2 36 37

$4\ 35 = 275''$

For fractional part

1st diff. - : $60''$ :: $697''$ :: $275''$: $50''$
2d diff. - 360 :: 697 :: $2^{\circ}\ 32'\ 2''$: 4
51 } 30° Ano. $2^{\circ}\ 32'\ 2''$ + 54 — 2 32 56 Man. P'ha.

Which subtract from Corrected Graba - -		0^{s}	4	30	57
☽'s Sputa Graha on the 13th of Poongoni -		0	1	58	1

The Moon's true place.

For Luni-solar distance.

☉'s Sputa Graha on the 13th Poongoni -	—	11	12	35	45
☽'s do. - - do -	+	0	1	58	1
Soob-vi-Arca Indoo Graha - - -		0	19	22	16

the Tidhi *Sputa*, or Argument of the true Tidhi on the 13th.

☉ and ☽'s distance at midnight.

How to find the end of the *Prathama* Tidhi, which began with the *Amavasya ending*, by means of that distance.

A

As the duration of a Tidhi is determined by the time that the Moon takes to run through 12° relatively to the Sun, we may have the Moon's true motion in one day, as we had that of the Sun, viz.

Moon's true motion.

☽'s Sputa Graha on the 12th Poongoni, at Lanca (page 89) — $11^s\ 17^\circ\ 51'\ 22''$

☽'s Graha on the 13th do. (page 111) - + $0\ \ 1\ \ 58\ \ 1$

☽'s Sputa Gati on the 13th - - - $0\ \ 14\ \ 6\ \ 39$ and

Relative motion.

Relative motion.

☉'s Sputa Gati - - - - — $59\ \ 26$

Vi-Arca-Indoo-Gati - - - - $13\ \ 7\ \ 13$

B

The distance on the 13th at true midnight at Lanca, was found (preceding article) - - $0^s\ 19^\circ\ 22'\ 16''$

Subtract motion for a Tidhi - - - — $0\ \ 12$

Arc of excess at midnight.

Excess of motion over a whole Tidhi at midnight - $7\ \ 22\ \ 16$

C

For time due to this excess, say

: as $13^\circ\ 7'\ 13''$ (Rel. mot.) : 60^g :: $7^\circ\ 22'\ 16''$: $\frac{60 \times 7^\circ\ 22'\ 16''}{13^\circ\ 7'\ 13''} = 33^\circ\ 42'\ 31''$

To be retrenched from midnight at Lanca.

Say therefore - - - - 45^g — $33\ \ 42\ \ 31$

End of the *Prathama* or Padhyami Tidhi.

End of the *Prathama* Tidhi - - - $11\ \ 17\ \ 29$ after Sun rise, and beginning of the *Vidya* Tidhi, or 2d Chaitram, A. C. 4924 current.

NOTE.

Registering the Tidhi.

As the *Vidya* Tidhi began on the 13th *after Sun rise*, it is to be coupled with the 14th of Poongoni, which is accordingly done in the Panchangum. (Vide page 67.) (*)

COROLLARY.

End of the *Vidya* Tidhi.

As $7^\circ\ 22'\ 16''$ had already been run through at midnight at Lanca on the 13th, if we take the same from - - - - - - 12° — $7\ \ 22\ \ 16$ = $4\ \ 37\ \ 44$

Beginning of the *Tadya* Tidhi.

we shall have the Arc which the Moon has to describe from the Sun before marking the end of the *Vidya* Tidhi, and beginning of the *Tadya*, or third Tidhi: but in order to get the correct time due to the same, the Sun and Moon's relative motion for the 14th of Poongoni must be computed; then the last proportion will hold good as before; et *Ceteris paribus*.

(*) Vide also description of the Siddhanta Chandra Panchangum, paragraph 10, page 72.

ARTICLE 11.

Resolution of a Cshaya Tidhi, or expunged Lunar day.

The Tidhis computed independently.

It has been observed (para. 7, page 72), that whenever a Lunar Tidhi commences and ends on the same Solar day, the precept requires that it be expunged out of the Kalendar; so that when such a case occurs, there is a chasm of an unit between two successive Tidhis. As this case recurs, on a medium, once in 64 days, the Epoch of any one *Cshaya* Tidhi being known, any other (past or future) may be anticipated within a day.

In the present Example I shall assume, that a mean Cshaya Tidhi was due about the 8th or 9th Vaisacha of the current year Cm. 4924 and proceed to the resolution of the same, following still the precepts of the Surriah Siddhanta.

In what follows, I shall only give in detail what may be new to the reader; but the quantities, the resolutions of which have already been explained, will be given in the abstract. It would, however, be quite impossible to give an intelligible account of what remains unexplored of these processes, if repetition were entirely excluded; and on that account I claim the reader's indulgence for unavoidable prolixity.

I.

For the Sun's mean place on the 8th Vyassei complete.

We have found at page 87, that the Sun's Madhyama Graha on the 12th of Poongoni, Sydereal time, was $11^s\ 9^\circ\ 26'\ 37''$.

A

To find the number of Savan days between the 12th of the Solar month Poongoni, 4923, and the 8th Vyassei 4924.

Number of days to be computed for the 8th Vyassei.

	Days.
By the Solar Kalendar the Sydereal month Poongoni counts -	31
Subtract - - —	12
	19
Duration of all Chaitram (Kal.) - - -	31
Proposed date in Vyassei - - - -	7 complete
Number of Savan days for which the Sun and Moon's motion is to be found -	57 days.

B. THE SUN.

By Table XX, we have for 50 days	1ˢ	19°	16′	48″
7 ,,	0	6	53	57
	1	26	10	45
Add Sun's Madhyama Graha, 12th Poongoni	11	9	26	37
Sun's mean place. ⊙'s Madh. Graha, 8th Vyassei complete, 9th current (*)	1	5	37	22

C. THE MOON.

	☽'s place.				Apogee.			
☽'s Madh. Graha, 12th Poongoni (page 89)	11ˢ	21°	15′	34″	7ˢ	4°	35′	53″
By Table XXI, for 50 days	9	28	49	3	0	5	34	9
7 ,,	3	2	14	4	0	0	46	47
Mean place of Moon and Apogee. Moon's Madh. Graha and Mandocha, 8th Vyassei complete; midnight at Lanca,	0	22	18	41	7	10	56	49

SECTION I.

A

Elements for the 8th Vyassei complete, A. C. 4924 current.

Elements. ⊙'s Madhyama Graha	1ˢ	5°	37′	22″
⊙'s Mandocha (motion insensible)	2	17	17	18
☽'s Madhyama Graha	0	22	18	41
☽'s Mandocha	7	10	56	49

Proceeding as before, these quantities will give us:

THE SUN.

⊙'s Anomalistic Argument or Manda Kendra		1ˢ	11°	39′	56″
,, Anomalistic Equation or Manda P'hala	+		1	27	30
,, Arca Bahoota P'hala			,,	,,	,,
⊙'s true place or Sputa Graha		1	7	5	6
,, true motion				57	28

THE MOON.

☽'s Anomaly		5ˢ	11°	22′	7″
,, Bhuja, Argument of Equation		6	18	38	8 (†)
,, Chandra Phala, Anom. Equa.	—		1	37	17
,, Arca Baa Sumscara P'hala	+			3	14

(*) This would be marked the 9th in the Panchangum, which always gives the *current* day. But as the fraction of the *Ahargana* for the 1st Vyassei is (Sunday) 38g. 10v. 10p. (as appears in the Kalendar given at the head of this Memoir), the Civil account for all that month dates *one* day less, and is therefore put down 8th current.

(†) ☽'s mean place	0ˢ	22°	18′	41″
Place of Apogee	7	10	56	49
	5	11	21	52
	12			
Manda Kendra	6	18	38	8

and

$0^s\ 22^\circ\ 18'\ 41'' - 1^\circ\ 37'\ 17''+3'\ 14''=0^s\ 20^\circ\ 44'\ 38''$

☽'s Sputa Graha at midnight of the 8th Vyassei complete, at Lanca.

,, *true* motion found as before 14° 16′ 19″.

B

Hence for the resolution of the end of the Tidhi, we have the following corrected Elements.

At midnight at Lanca	☉'s Sputa Graha	1ˢ 7° 5′ 6″	True distance 8th Vyassei complete.
	☽'s do. do.	0 20 44 38	
☉ and ☽'s true distance		0 16 20 28	
At Lanca	☉'s Sputa Gati	0° 57′ 28″	End of 8th.
	☽'s Do. Do.	14 16 19	
Soob-ri-Arca Yndoo Gati or Relative Motion		13 18 51	

C

Resolution of the end of the Tidhi.

As the Moon moves through 12 degrees of her Synodical Revolution in one Tidhi, the Hindu Astroomers have found means of abridging the process hy computing, first "How many "complete Tidhis have elapsed in the *Bhuja*, or complement to 360° of the Sun and Moon's "Revolutions on the proposed day; and, secondly, by finding the time due to the remainder." Shortening the process.

Now having found this to be - - - 0ˢ 16° 20′ 28″
12

Bhuja — 11 13 39 32
or 343° [39 32

1º Say : As 12° : To 1 Tidhi :: 343° :

: $\frac{1\times 343}{12^\circ}$ = 28 Tidhis complete, with a remainder of 7°+39′ 32″ of the *Bhuja* unaccounted for, hut which shall be considered presently. Number of Tidhis expired on the given day.

The quotient, which was found to be 28, shews that the Tidhi sought, is the 28th of the Lunar month Vatsacha complete, and as we have worked for the 8th Vyassei Solar time, also complete, that Tidhi is to be coupled with the said Solar day.

And on account of the division of the Lunar month into two *Patchums*, it is customary to register the same 28—15=13th Christna Patchum; which is accordingly done in the Panchangum, page 67.

To proceed.

2º As there were 28 complete Tidhis expired at the time for which the computation was made, the remainder, after division by 12° (viz. 7° 39′ 32″) indicates a part of the 29th Tidhi (then current) which had expired, and in order to determine its end, or the beginning of the 30th Tidhi (which is always that of the conjunction)

Say - - - - - - From 12°

Take 7 39 32

Remainder to the conjunction.

Arc due to what remained of the 29th Tidhi, in degrees, &c. at midnight at Lanca } 4 20 28

D

For the time due to this Arc, considering that a great portion of the 29th Tidhi will fall on the 9th Vyassei, we require the *true* relative motion for that day, which, proceeding as before, will be found to be - - - - $13^{\circ}\ 22'\ 26''$

For the end of the 29th Tidhi.

Say therefore,

: Relative motion $13^{\circ}\ 22'\ 26'' : 60^{g}$ ::

Arc of complement $4^{\circ}\ 20'\ 28''$:

: Time due to Arc from midnight at Lanca $\frac{60 \times 4^{\circ}\ 20\ 28}{13\ 22\ 26}$ - - - - $19^{g}\ 28^{v}\ 32^{p}$

Add midnight 45

61 28 32

Subtract 60

Time of 29th Tidhi ending after Sun rise on the 9th Vyassei, or beginning of the 30th $4^{g}\ 28^{v}\ 32^{p}$

Registering the Tidhi.

Thus, the 30th Tidhi of the Lunar month Vaisacha having begun *after* Sun rise on the 9th of the Solar month Vyassei, if nothing had intervened, should have been coupled with the 10*th* of the said month. The remainder of the Example will shew us, whether the case admits of that arrangement.

SECTION II.

A

For the end of the 30th or Amavasya Tidhi.

For the 30th or Amavasya Tidhi, being an *expunged* one.

Proceeding as before, for the 9th Vyassei we shall find

At midnight at Lanca } ☉'s Sputa Graha, 9th - - - $1^{s}\ 7^{\circ}\ 44'\ 3''$

☽'s Do. Do. - - - - 1 5 2 58

☉ and ☽'s distance - - - 0 2 41 5

Relative motion.

At Lanca } ☉'s Sputa Gati, 9th - - - $57'\ 26''$

☽'s Do. Do. - - - - 14 19 52

Relative motion - - - - - 13 22 26

B

For time due to distance.

Say As relative motion - - - - - $13^{\circ}\ 22'\ 26''$

To one Savan day - - - - - 60^{g}

So distance at midnight - - - 2 41 5

To $\frac{60 \times 2^{\circ}\ 41'\ 5''}{13^{\circ}\ 22\ 26}$ - - - $12^{g}\ 2^{v}\ 40^{p}$

After midnight at Lanca, which marks the true time of conjunction, and consequently the end of the 30th, or Amavasya Tidhi.

End of the 30th Tidhi.

To express the same in Solar time, we have		45^g	
	+	12	2 40
Time after Sun rise on the 9th		57	2 40
		60	
The same before Sun rise on the 10th		2	57 20

CONCLUSION.

As the 29th Tidhi ended at $4^g\,28^v\,50^p$ after Sun rise, and the 30th on the same day at $57^g\,2^v\,40^p$, it is manifest that the whole of the 30th or Amavasya Tidhi, was expended during the 9th of the Solar month Vyassei, and therefore, that it is a *Cshaya, or expunged Tidhi.* It is accordingly left out of the Panchangum; but its name and duration are inserted in the margin. (*) There is, in consequence, no 30th Tidhi registered in the column for the month Vaisacha (page 67.) Hence also the *Prathama Tidhi* of the Lunar month Jaish'ta, falls on the 10th Vyassei, Civil account; for (as has been said in the note at the foot of page 114,) it falls truly on the 11th Sydereal day current, but as Vyassei commenced at *night time*, its Civil beginning fell *one day later*, and hence the 11th Sydereal is only the 10th Civil day of that month. (Vide Skeleton of Luni-solar Kalendar, ibid.)

The *Cshaya* Tidhi determined and left out of the columns of the Kalendar.

The case of the *Adigah*, or repeated Tidhi, being resolved precisely like that of the *Cshaya*, I shall not detain the reader by any further example.

The same process applies to the resolution of the intercalary days.

I shall now take leave of the Surriah Siddhanta, and enter on the consideration of the *Vakiam* or Solar process.

(*) Oppadi or Cshaya Amavasya Tidhi 52g. 33v. 50p. the duration of that Tidhi being 57g. 2v. 40p.—4 28 50 =52 33 50.

PART II.

Of the Solar or Vakiam process.

In the first part of this Memoir we have explained the principles on which all Indian Kalendars which (like that of the Tellingas) rest on the doctrines of the Surriah Siddhanta, are to be constructed. In the second we shall disclose the mechanism of the Solar Kalendar, which is much more extensively used in the Southern parts of India than the former, being that of all the countries where the Tamul language prevails.

The process of Solar Astronomy.

Both Kalendars contain precisely the same Astronomical and Astrological articles, the only difference being, that the Elements from which the *Vakiam* Rules and Tables are constructed, are extracted from the *Ariah*, instead of the *Surriah* Siddhanta; and that the mode of proceeding for resolving the different Problems is totally different.

This process was, I believe, the first that became known to Europeans; and considering the nature of its *ostensible* Elements, and how concealed the *real* ones lie in its Tables and formulæ from their original source, it is no wonder that the appearance of these, at the time of discovery, should have led, (even very scientific men) into the most extraordinary conjectures.

The most remarkable difference between the Vakiam process, and that of the Surriah Siddhanta, is, that the computations of the former are directly for the *apparent*, without previously obtaining the *mean* places of the Asters; and that these refer to the time of *Sun rising*, instead of *mean midnight*, as is directed in the Surriah Siddhanta.

In the Key to the *Madhyama Saura mana* we have given all that was necessary for the resolution of mean Solar, into European dates, therefore in the present division of the *Kala Sankalita*, we shall only attend to *Luni-solar* and *Solar* Hindu times.

The primary Elements of the Vakiam and those of the *Ariah Siddhanta.*

The Elements of the *Vakiam* process being those of the Ariah Siddhanta, the Solar year consists of $365^d\ 15^g\ 31^v\ 15^p$ as was used in the Madhyama Saura mana (*): the construction of

---

(*) According to that Sastra there are 1577917500 Bhumi Savan days (called Yuga dina) in a Maha yug, being 328 days less than by the Surriah Siddhanta. The Solar year is therefore $\frac{1577917500}{4320000}$ - 365d. 15g. 31v. 15p. or 365d. 6h. 12′ 30″ in European time. Of periodical Revolutions of the Moon relatively to the Equinoxes, there are 57753336 in a Maha yug, the Lunar periodical month is therefore $\frac{1577917500}{57753336}$ - 27d. 19g. 17v. 58p. 29s. &c. or 27d. 7h. 43′ 11″ 23‴ &c. in European time. If from the number of periodical Revolutions of the Moon we subtract 4320000 Revolutions, we have 57753336—4320000=53433336 Synodical Revolutions of the Moon in a Maha yug; therefore $\frac{1577917500}{53433336}$ – 29d. 31g. 50v. 5p. 40s. &c. or 29d. 12h. 44′ 2″ 16‴ &c. European time, is the mean duration of a mean Synodical Revolution of the Moon, according to the Ariah Siddhanta.

The Moon's Anomalistic Revolution is particularly noticed in the text, but in the Elements of the Vakiam it is taken to be 27d. 33g. 20v. Indian, and 27d. 13h. 20′ European time.

that year is, therefore, to be used in the present process, instead of that which was given in the Skeleton for the *Siddhanta* Solar year 4924, at page 65; and the Roots of each of the 12 months, as well as the aggregate number of days in the concurring Lunations, will be,

Names of Solar months.	Types of Signs.	Roots of Ahargana for beginnings of Solar months.				Number of days in each month.		European dates of beginnings N. S.	Dom. Letter.		Lunations.	Aggregate time of Lunations.				
		D.	G.	V.	P.	Sydereal.	Civil.					D.	G.	V.	P.	S.
Poongoni 1423	♓	(1)	59	51	28			11 March 1822	F		1	29	31	50	5	40
Chaitram 1424	♈	(4)	20	12	30	31	30	11 April 1822			2	59	3	40	11	20
Vyassei	♉	(0)	15	44	31	31	31	12 May			3	88	35	30	17	0
Auni	♊	(3)	39	56	32	31	32	12 June			4	118	7	20	22	40
Audi	♋	(0)	16	34	33	32	31	14 July			5	147	39	10	28	20
Auvani	♌	(3)	44	46	35	31	32	14 August			6	177	11	0	34	0
Paratasi	♍	(6)	46	56	36	31	31	14 September			7	206	42	50	39	40
Arpesi	♎	(2)	14	18	37	31	30	15 October			8	236	14	40	45	20
Cartiga	♏	(4)	8	25	38	30	30	14 November			9	265	46	30	51	0
Margali	♐	(5)	38	49	40	29	30	13 December			10	295	18	20	56	40
Tye	♑	(6)	59	42	41	29	29	11 January 1823	E		11	324	50	11	2	20
Manssi	♒	(1)	26	58	42	30	29	10 February			12	354	22	1	3	0
Poongoni	♓	(3)	15	22	43	30	30	12 March			13	383	53	51	13	40
Chaitram 4925	♈	(5)	35	43	45	30	31	11 April								

N. B.—The Solar Ahargana may be found by means of Table XLVIII, part 2, of this collection, as follows:

	D.	G.	V.	P.
for 4000 yrs. - - -	1461034	43	20	0
900 - - -	328732	48	45	0
20 - - -	7305	10	25	0
8 - - -	1095	46	33	45
	1798168	29	3	45
Subtract *Sodhyam* or Equation —	2	8	51	15
Solar Ahargana for the beginning of A. C. 4924 - -	1798166	20	12	30

Solar Ahargana beginning of 4924 of the Cali yug.

With respect to the Luni-solar Ahargana, the Elements of the Ariah Siddhanta will give some difference from that which we found to proceed from those of the Surriah Siddhanta; but in this place, we can only account for that variation in a summary way. We shall, however, renew the full discussion of that subject in the Note where the method of resolving that Element by the Tables will be considered.(*)

(*) The Rule for resolving the Luni-solar Ahargana is precisely the same as that used with the Elements of the Surriah Siddhanta; and therefore need not be repeated, but the same may be found with much less trouble by means of Table XLIX.

Luni-solar Ahargana end of the year 4923 of the Cali yug.

It will be seen in the marginal note of the preceding page, that according to the Ariah Siddhantu, a mean Lunation is $29^{d}\ 31^{g}\ 50^{v}\ 5^{p}\ 40^{s}$ &c. consequently that the Lunar year of 12 months consists of $354^{d}\ 22^{g}\ 1^{v}\ 8^{p}\ 2{,}6^{s}$ &c. Now as we require the Luni-solar Ahargana for the end of the year 4923 of the Cali yug, it will be found that in this number of Solar years, there are 5074 Lunar years, and three Lunar months over, in all 60891 Lunar months, which, therefore, multiplied by one mean Lunation gives $29^{d}\ 22^{g}\ 1^{v}\ 5^{p}\ 2{,}6^{s} \times 60891 = 1798146^{d}\ [39^{g}\ 24^{v}\ 28^{p}\ 53^{s}$

And for the current day - - - + 1

The Luni-solar Ahargana sought - - 1798147

This Ahargana differs in appearance, one day from that resulting from the Elements of the Surriah Siddhanta, but in reality only $22^{g}\ 24^{v}\ 51^{v}$ or $8^{h}\ 57'\ 56''\ 24'''$ European time. It will be seen presently, that this variation is of no sort of importance, because the apparent position of the Sun and Moon elicited by *any* Ahargana and the Vakiam Tables will soon shew, whether the Asters be within one day of the conjunction, or not; and in the latter case, the Ahargana must yield to the circumstance, and be fitted to the proper time.

The Ahargana of the Ariah or Surriah Siddhanta may be used indiscriminately.

For the Soota dina, or feria of last conjunction, we have as usual 7)1798147(256878

with a remainder of - - - 1 to be counted

from Thursday. The Soota dina therefore, falls on *Friday*, and as the following Saturday was formerly found to fall on the 12th of the Solar month Poongoni complete of A. Cali yugam 4923, this Friday falls on the 11th of the same month, (also *complete*) which means the time of Sun rising on the 12th.

Article 1.

Of the Elements and their construction.

The Sun and Moon's apparent places in the Hindu Zodiac for apparent time at Sun rising at Lanca, are to be obtained by means of the following Elements and process.

1º The Sun's place is determined by converting the number of months, days, guddias, viguddias, &c. into signs, bagahs, calas, and vicalas; being that measure of time which the

Solar Ahargana	1798166d
(0)	1744548
	53618
(1)	35436
	18182
(2)	17718
	464
(3)	354
	110
(4)	88
	22

	Years.		D.	G.	V.	P.	S.
	4000		1417 67	55	36	13	20,0
	900		318930	17	0	39	0,0
	20		7057	20	22	40	52,0
	3		1063	6	3	24	7,8
		(0)	1744518	39	2	57	19,8
Intercalations	100	(1)	35436	41	53	24	20,0
	50	(2)	17718	20	56	42	10,0
	1	(3)	354	22	1	8	2,6
	3 months	(4)	88	36	30	17	0,6
			1798146 [39	24	28	53,0	
			+ 1				
Luni-solar Ahargana sought -			1798147				

Generation of the Elements.

Hindus, in a special sense, call Saura (*). In this account, all days and fractions are always equal to one another, a sign corresponding to one month, a degree to a day, &c.

The Sun's place at his rising at Lanca.

2º By equating (by means of a Table called Yoghiadi, the XXVIIth, 1st part, of this collection) the Arc so expressed, into that really gone through by the Sun in the same space of time; of which Table and operation a particular explanation follows.

His motion.

3º By finding the Sun's true motion from eight to eight days, or, approximatively, for every day by means of the same Table, part 1; and still more correctly by the second part thereof, if judged necessary.

The Moon's place for the same instant.

The Moon's apparent place is deduced for any proposed time, from her place at the beginning of the Cali yug. The rule includes at once her motion, and that of her Apogee; and the period when she completes a certain number of true Anomalistic revolutions in a known place of the Zodiac, affords means for finding how far, at any given time, she is advanced in a period of 248 days (called Devaram), which is taken to be equal to 9 of her Anomalistic revolutions; then, by help of another Table (the XXVIth of this collection), we know how much she takes to pass through each degree of her orbit, during the said period; and how far she is advanced at the proposed time in the Hindu Zodiac.

Anomalistic revolution of the Moon.

On calculating the number of Anomalistic revolutions which have occurred from the origin of the Cali yug, to any assigned period, the Hindu Astronomers have determined that there were exactly 3785 Anomalistic revolutions of the Moon in 105952 mean Tidhis; from which they concluded that there were 27,9926024 mean Tidhis in one revolution; and as the mean Tidhi is to the Bhumi Savan day as $\frac{59^{g}\ 3^{v}\ 38^{p}}{60}$, they concluded $27^{d},554600$, or $27^{d}\ 33^{g}\ 16^{v}\ 33^{p},62$ in natural days for the same. The period, however, which is used in the *Vakiam* process, differs a little from the above; being $27^{d}\ 33^{g}\ 20^{v}$; i. e. $3^{v}\ 26^{p},38$, or in European time 1′ 22″,4 &c. longer.

The Elements for the Moon's apparent place, referred to Sun rising at Lanca.

The Moon's apparent place at Sun rise on any day at Lanca, is to be determined by means of five Elements, called *Vedam*; *Raza Gherica*; *Calanilam*; *Devaram*; and *Chandra Vakiam Dhurmavanham*: which are generated as follows.

1º The Devaram.

The Devaram.

Multiply one Anomalistic revolution of the Moon, $27^{d}\ 33^{g}\ 20^{v}$, by 9, and you have 248 days without a remainder, called a *Devaram*, when the Moon's place in Apogee is 0ˢ 27° 44′ 6″ from the beginning of the Solar Sydereal Zodiac.

(*) Vide Glossary at the end.

2º The Calanilam.

Calanilam.

Multiply one *Devaram* or 248^d, by 12, and you have - -	2976^d
Add two Anomalistic revolutions of the ☽, - -	55 6 40
A Calanilam - -	3031 [6 40

neglect the fraction; and the Moon's place in Apogee is $11^s\ 7^\circ\ 31'\ 1''$. (*)

3º The Raza Gherica.

Raza Gherica.

Multiply one *Calanilam*, or 3031^d, by 4, and you have - -	12124^d
Add one *Devaram* - - - - - -	248
A Raza Gherica - - -	12372

and the Moon in Apogee is $9^s\ 27^\circ\ 48'\ 10''$.

4º The Vedam.

Vedam.

Multiply one Anomalistic revolution or $27^d\ 33^g\ 20^v$, by 8, and you have -	220^d
Multiply one *Devaram* or 248^d, by 7 - - - -	1736
Add one *Calanilam* - - - - - -	3031
Multiply one Raza Gherica or 12372^d, by 129 - -	1595988
Add $\frac{1}{3}$ of Moon's Anomalistic revolution, neglecting the fraction -	9 [11 6 40
The sum is a Vedam - - - -	1600984

and the Moon's place in Apogee is $7^s\ 2^\circ\ 0'\ 7''$.

Let these four Elements be arranged in the inverse order from that in which they were generated.

	Number of Days.	Place of the Moon in Apogee.
One Vedam	1600984	7^s 2° 0 $7'$
,, Raza Gherica	12372	9 27 48 10
,, Calanilam	3031	11 7 31 1
,, Devaram	248	0 27 44 6

The Chandra Vakiam Dhurmavanham. To deduce the *Chandra Vakiam Dhurmavanham*, (which is the fifth Element of the Solar process) from the four preceding ones, it is supposed that the Solar and Luni-solar *Ahargunas*, are previously known. Taking these as data, we have the following,

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(*) There are two fractions arbitrarily neglected in the construction of these Elements, viz. 6g. 40v. in the *Calanilam*, which produce a difference of 26g. 4v. (in *minus*) in the Raza Gherica. In the Vedam, the neglecting of this fraction, together with 11g. 6v. 40p. on the third part of one Anomalistic revolution, will produce a very considerable Equation.

Thus on 1 Calanilam - - - -	0d 6g 40v 0p
On 129 Raza Gthericas - - -	57 20 0 0
On 1-3d of 1 Anom. Revolution -	0 11 6 40
	57 37 46 40
Two Anomalistic Revolutions 2×27d. 33g. 20v. - - -	55 6 40 0
Difference on one Vedam. 2 Anomalistic Revolutions - - +	2 31 6 40

I could obtain no information on the reasons which have renderad the subtraction of that quantity necessary for having the Moon's true place at the end of a Vedam.

PRECEPT.

For the Argument of the Moon's Equation.

Precept.

" Divide successively the Luni-solar *Ahargana* by 1 Vedam, 1 Raza Gherica, 1 Calanilam and " 1 Devaram, the remainder in days will be the *Chandra Vakiam Dhurmavanham*, which is the " Argument of Table XXVI, both for the Moon's true place and motion."

Elements for the Sun's Apparent place.

PRECEPT.

Elements for the Sun's apparent place.

Precept.

" 1º Convert the number of months and days elapsed since the beginning of Chaitram ♈, " the former into the numeral of the last Sign gone through by the Sun, the latter into degrees, " which will answer to the time expired at the end of the proposed day.

" 2º If the month (whatever be the day computed for pending its duration) begins at day " time, *deduct* the guddias as calas, which had elapsed between Sun rise and the time of his " entering a new Sign; the remainder will give his *Saura* place on the morning of the day on " which the Sydereal month commenced.

" 3º If the month begins at night time, *add* the guddias as calas which are wanting to com" plete the night and begin the next day.

" 4º To find the Sun's Equation for one day by means of the *Yoghiadi* Table, divide by 8 " the quantity given therein for the day itself; or (if it be not in the Table) for that nearest " below it, and the quotient will be the Equation of the Sun's true motion to 1° in a day, sup" posed to be his true progress during 8 days.

" 5º Multiply the Equation thus found by the number of days you require in the interval of " 8 days, and the product will be the Equation required.

" 6º The Equations so obtained are *additive* from the beginning of Arpesi to the end of " Maussi, and *subtractive* from the beginning of Poongoni to the end of Paratasi."

As the preceding precepts are insufficient for a clear understanding and application of Table XXVII, the following article is intended for giving the reader a more distinct view of its construction.

ARTICLE 2.

Account of the Vakiam Tables.

1º Of the Chandra Phala and Sputa Gati Table, being the first of the Vakiam process and the XXVIth of this collection.

Of the Chandra Phala and Sputa Gati Table.

The Argument of this Table is the *Chandra Vakiam Dhurmavanham*, or the remainder in days of the *Ahargana*, after division by the four Elements above described, 248 of these (equal to one Devaram) are registered in the first column.

The second column contains the Chandra Phala, or Moon's Equation, always to be added to her *Druva*, and the third gives her true motion for each Vakiam day.

The Moon's Equation always additive.

The same always taken, for the Vakiam day found by the operation.

The *Equation* is in all cases to be taken for the Vakiam day itself, such as indicated by the operation: but the Moon's true motion may be taken for that or the next day, according to the following rule.

The Moon's motion to be taken for the next day when the conjunction is to come, or the Tidhi ending.

If by the result of the operation it appears that the conjunction has not yet occurred, or (if during the course of the Lunar month) that the Tidhi is at, or near its end, then the Chandra Cati, or true motion, is to be taken for the next day to that indicated by the Vakiam (or Argument).

The same to be taken for the day itself when the conjunction is passed, or the Tidhi beginning.

But if at the time of Sun rising it appeared from the Sun and Moon's Longitudes that the conjunction had passed over, or that more than one half of the Tidhi was expended, then in such a case, the Moon's true motion is to be taken as given in the Table for the day itself.

The Moon's *mean* motion, to which her *true* one is referred in Table XXVI, is 791 calas, or 13° 11′ per diem.

Account of the Yoghiadi Table, being the second of the Vakiam process and the XXVIIth of this collection.

OF PART FIRST.

1st Part of the Yoghiadi Table.

The account which was originally given to me of this Table was so very unsatisfactory, that it was a long time before I could understand its right application.

The Moon's true motion referred to 1° to a day.

Independently of the precept which we have delivered in the preceding pages, it is *to* be understood that the calas or minutes given in the 4th column opposite to any day *of the month* in the division of which it is registered, represents the Equation *of the* Sun's *motion* in *plus* or *minus* to 1° for each day, for *eight* consecutive days. So that *if opposite to the* 1st day in the month Chaitram we find 11 calas, we are to understand that *so many* minutes will be the complete Equation due *on the eighth complete day* of the said *month*.

These 11 calas divided by 8, give a quotient of 1′ 22″ 30‴, which is the *mean* daily Equation used by common computers from the 1st to the 8th Chaitram complete.

But on the 9th day this Equation varies, for by the Table it gives 14 calas, meaning the aggregate Equation from the 8th to the 16th, both complete. During that interval the daily Equation will therefore be 1-8th of 14′ or 1′ 45″; and if we want that due to the 9th, it will be 11′+1′ 45″=12′ 45″, the second member being added because the calas are increasing; but the whole Equation is subtractive, on account of the Sign — expressed in the column of months. Proceeding in the same manner, we shall find the Equation for the 16th Chaitram complete, to be 11′+14′=25′ also subtractive.

Lastly, if the month Chaitram of the proposed year happened to be of 32 days and the Equation for its last day were required, we would add 11′+14′+16+17′ (those due to 1st, 9th, 17th, 25th days,)=58′ for the quantity sought.

But then on the ensuing day, because the Sun would enter a new Sign, all the foregoing Equations would be abandoned, and if it happened to enter the Sign Vrisha ♉ at it's rising (which very rarely occurs), the Equation for that instant would be Zero. I shall illustrate the foregoing exposition by a few Examples.

The Equation equal to 0, when the Sun enters a new Sign at his rising.

EXAMPLE I.

Let it be required to find the Sun's apparent place on the 15th Chaitram of the 4924th year of the Cali yug current, at his rising at Lanca.

The Sun's place for 15th Chaitram A. C. 4924.

On the 1st Chaitram the Sun entered the Sign Mesha ♈ at $20^g\ 12^v\ 30^p$ after Sun rise (1st General Table), then

☉'s place, 1st Chaitram	0ˢ	0°	0′	0″
For 15 days complete		15	0	0
	0	15	0	0
But as at his rising he was still in the Sign Min ♓, therefore we are to deduct the guddias as *culus* for $20^g\ 12^v\ 30^p$		—	20	13
☉'s Saura place, 15th Chaitram	0	14	39	47

To find his Equation, the *Yoghiadi* Table gives for 8 days complete 11 calas, we want therefore for 7 days more; and finding 14′ for 9th Chaitram, the 1-8th part of that quantity or 1′ 45″ is the daily Equation from the 8th to the 16th complete: therefore 7×1′ 45″=12′ 15″, is the Arc to be added to 11 calas, before found; the sum amounting to 23′ 15″.

But we have retrenched from the Sun's Saura place 20′ 13″, on account of 20 guddias, 13 vig. (nearly), in the ratio of which we are to decrease the above Equation.

Now having found that the daily Equation from the 9th to 17th beginning, was 1′ 45″.

Say : 60^g : 1′ 45″ :: $20^g\ 13^v$: 35″ and			23′	15″
	—			35
Corrected Equation	—		22	40
☉'s Saura place above found		14°	39	47
His *Sputa Graka* or true place sought		14	17	7

EXAMPLE II.

The same for the 24th Audi complete of the 3724th year of the Cali yug.

The Sun's place 24th Audi 3724.

Let us take for data, that the Sun entered the Sign Carcata ♋ on the 1st Audi of the proposed

year, at	51^g	34^v	33^p
	60		
After Sun rise—remains of the day	8	25	27

Proceeding as before, say, 1st Audi	3ˢ	0°	0′	0″
For 24 days complete		24	0	0
For the time wanting to Sun rise			8	25
☉'s Saura place, 24th Audi	3	24	8	25

The Table XXVII, part 1, for 8 days in Audi gives 21′; for 16^d, 23′; for 24^d, 22′, and in the present case, as the Equation is required exactly for 24 days, all these calas being added together give 69′ for part of the Equation sought.

But we have added, for 8^g 25^v 27^p that remained of the day, an Arc of 8′ 25″ to the Sun's Saura place; the Equation must therefore be increased in ratio to the same.

As on the 24th Audi complete it was 22′; 1-8th thereof is 2′ 45″, the daily Equation from the 17th to the 25th.

Say therefore : 60^g : 2′ 45″ :: 8^g 25^v 22^p : - -	+ 22
Equation above found - - - - -	1 9 0
Corrected Equation - - - —	1 9 22
☉'s Saura place, 24th Audi complete - -	3 24 8 25
Sun's *Sputa Graha* sought - - - -	3 22 59 3

How to compute the Sun's true diurnal motion.

These two Examples will suffice to show, how the Sun's Saura place may in all cases be equated to his true one. There remains now to explain, how the Sun's daily motion is to be computed by means of the same Table, which however, has been in a great measure explained in the preceding article; for the mean daily motion for 8 days is obtained by dividing by 8, the calas registered opposite to the day next below the proposed one, the quotient being the Equation ± to be applied to 60′ for obtaining his true motion on the same day.

EXAMPLE 1.

Wanted the Sun's true motion on the 15th Chaitram 4924.

From Table XXVII, *part* 1, *take the calas opposite to the 9th* Chaitram, which are 14′; 1-8th of which, 1′ 45″, is the Equation from the 9th to the 17th, being subtractive.

	60
	1 45
Uncorrected Sun's diurnal motion - - -	58 15

and by the common Tamul Kalendar makers, this quantity is used indiscriminately as the true motion on any day during that interval.

Second differences of the Sun's diurnal motion.

But the few who aim at greater accuracy, take the second differences,—seldom, it is true, for equating the Sun's Saura to his true place, but frequently for finding his true motion on any specific day, the process of which is as follows:

Take the calas for the ensuing eight days, which in the present case will be those for the 17th

Chaitram, viz. 16′; 1-8th of which is - - - -		2′	0″	
Equation for the 9th, as above found - - - -		1	45	
Difference			15	
then $8^d : 15'' : 6^d : 11'' 22'''$ &c. which as the calas are increasing, add to		1	45	
	+		11	22
Corrected Equation - - -	—	1	56	22
Which subtract from - - - - -		60		
☉'s true motion on the 15th Chaitram - - -		58	3	33
N. B.—In Table XXVIII that Equation is - -		58	8	
Difference			4	22

on the 17th as the calas are 16′, the Equation would be 2′ and the Sun's motion exactly 58′.

Observation.

It is manifest that these corrections are equally applicable to the Equations for reducing the Sun's *Saura* to his *true* place; and it may appear singular that, whereas in equating the Sun's Longitude, the Tamul computers never omit to take into consideration that fraction of the day which marks the interval between Sun rising, and his entrance into a new Sign (whatever be the day of the month computed for) yet when calculating the Sun and Moon's distance and relative motion, they should entirely overlook these second differences.

Of the second Part of Table XXVII.

2d Part of the Yoghiadi Table.

Its Epoch A C. 4940 complete A. D. 1839.

This part serves to find the Sun's Anomalistic Equation, and consequently the Solar and Luni-solar Arca Bhagâbalas, and the Sun's true motion for every day in the year, much more accurately than the first. Its Epoch is the beginning of the 4941st year of the Cali yug, answering to the 11th April 1839, when the place of the Sun's Apogee will be in $2^s\ 17^\circ\ 17'\ 20''$.

This quantity, which is to be found at the head of the fifth column, is the Supplement of the Sun's Anomaly to a complete Circle, on the 1st Chaitram, at the precise time when he will enter the Sign Mesha; and is therefore the Argument of his Equation for that day. The following quantities are the same for the beginning of the succeeding Solar months; but in using these, the positive and negative Signs must be taken as given in this Table, and not as exhibited in Tables XXII and XXIV, because the Argument of the former is always the Supplement of the Sun's Anomaly; and of the latter, the Anomaly itself; whereas in the 2d part of Table XXVII, it is either the one or the other, or their respective Bhujahs to the Sun's Apogee or Perigee, conformably to the rules of the Sastras, a construction which saves the possibility of error.

The Sun's true motion referred to his mean diurnal motion or 59′ 8″.

The Sun's true progress is referred, in this second part, to his mean motion, or 59′ 8″, and not to 60′, as in the first. The positive and negative Signs in the 7th column, indicate when the apparent is greater or less than the mean motion, following the same order as in part 1st, which however, has not the advantage of shewing the precise day when the Signs change.

I shall now proceed to give some examples of the application of this Table: but it is to be understood that, neither its first nor second part can be considered as affording results strictly correct, for I cannot find that any part of the Vakiam process can pretend to more than furnishing approximations, the limits of which, when compared to the resolutions by the Surriah Siddhanta modified by the Tikas, are by no means narrow.

EXAMPLE I.

The Sun's true motion and Arca Bhagábala for the 15th Chaitram 4941.

Let the Sun's Equation, true motion, and Solar, as well as Luni-solar Arca Bhagábala, be required for the 15th Chaitram of the 4941st year of the Cali yug.

1º The Argument of the Sun's Equation for the 1st Chaitram, by Table

XXVII, part 2, is - - - -	2ˢ 17° 17′ 20″
His mean motion for 15 days, by Table XX -	— 14 47 3
	2 2 30 17

which motion is to be subtracted, because the Argument is decreasing in the fourth quadrant of Anomaly.

2º With 62° 30′ 17″ as an Argument, refer to either Tables XXII or XXIV (but in preference the latter, because it gives the Equation for every degree), and the *Ravi P'hala* will be found 1° 56′ 4″, which is to be taken as positive on account of the sign + in Table XXVII, part 2.

The same Argument will give the difference between the true and mean daily

motion of the Sun - - - - - - —	59″
	59 8
☉'s true motion, 15th Chaitram 4941 - - - -	58 9
N. B.—The same by the Table XXVIII - - -	58 8
Difference	1

The Solar and Lunar Arca Bhagábala will be found as usual, viz.

The ☉'s - - - - - $\frac{1° 56′ 4″}{365} = +19″$

The ☽'s - - - - - $\frac{1\ 56\ 4}{27} = +4′ 17″$

but the Sun's is not used in the Vakiam process.

EXAMPLE II.

The same for 20th Audi 4941.

The same for the 20th of Audi ♋ of the same year.

The Manda Kendra, or Argument for 1st Audi, column 5th, is		0^s	12°	42′	40″
Add Sun's motion for 20 days, because the Argument is increasing in the 1st quadrant			19	42	43
Argument, 20th Audi		1	2	25	23
	or		32°	25′	23″
The Equation answering to which is	—		1	10	47
Difference between ☉'s true and mean motion	—			1	53
☉'s true motion, 20th Audi				59	8
				57	15
N. B.—The same by Table XXVIII,				57	14
☉'s Arca Bhagábala — 11″	Difference				1
☽'s do. — 2 37					

Example III.

The same for the 18th Paratasi.

The same for the 18th Paratasi of the same year.

Argument, 1st Paratasi, column 5th		2^s	12°	42′	40″
☉'s mean motion for 18 days, Table XX,			17	44	36
To be added because the Argument increases in the 1st quadrant of Anomaly		3	0	27	16
Equation	—		2°	10′	32″
1-365th of which is the ☉'s Arca Bhagábala	= —				21
1-27th the Lunar Arca Bhagábala	= —			4	48
Equation of true to mean motion					0
True motion, 18th Paratasi				59	8

which is the same as that given in Table XXVIII.

Example IV.

The same for the 18th Margali.

The same for the 18th Margali of the same year.

Argument, 1st Margali	—	0^s	17°	17′	20
☉'s mean motion for 18 days	+		17	44	36
Of which take the difference		0	0	27	16
The Equation answering to this Argument	—		0°	3′	23″
☉'s Arca Bhagábala insensible. ☽'s = 3′.					
Equation of ☉'s true to mean motion	+			2′	18″
				59	8
☉'s true motion on the 18th Margali, which is at its maximum				61	26

By Table XXVIII the same.

These operations are so obvious, that it would be a waste of time to carry them any further. They leave little doubt in my mind that Table XXVIII (which was communicated to me by a Native Astronomer) was computed by means of the 2d part of Table XXVII, though in some instances I have found a few seconds of difference.

N. B.—As the Sun's Apogee is supposed to move at the rate of 1′ in 517 years, the latter Table may easily be fitted to any remote Epoch, by a common rule of proportion, all the Arguments being equally affected by its motion.

Of Table XXVIII.

Of Table XXVIII, being the 3d of the Vakiam process.

This Table furnishes the Sun's true diurnal motion for every day in the year, and therefore requires no particular explanation. I suspect it to have been constructed by the person who communicated it to me, by means of the 2d part of Table XXVII. Be this as it may, as it saves the trouble of computing the Sun's true diurnal motion by either of the processes which we have formerly explained, I have thought it deserving to be inserted in this collection.

Table XXVIII, as well as the preceding one, supposes the Sun's Apogee in 2ˢ 17° 17′ 20″, and on account of the slowness of its motion, will be sufficiently true for a great number of years.

Of Table XLVII. (*)

Of Table XLVII, being the 4th of the Vakiam process.

I profess to understand very imperfectly the construction of this Table, which was communicated to me by a Native Kalendar maker named *Sami Nada Sashya*, who made all his computations with shells and tamarind seeds, but who, (though he used it constantly), could not give me the least account of the theories on which it was grounded.

There can be no doubt, however, both from the name given to the quantities registered in the 2d column, and from the manner of using it, that it accounts for the effects of the difference of Longitude on the Moon's apparent motion, between Lanca and some other place (†), which *Sami Nada* believed to be *Tanjore*, but in my opinion *Trivalore*, because that place lies not far from it, and is still reputed to be the seat of the sciences in these Southern parts of the Peninsula.

This Table, I was informed from the same source, is used indiscriminately for all places between Cape Comorin and Madras, though my informer acknowledged it would not do for *Malasyan;* by which he meant the Coast of Malabar. The lateness of the Epoch when this Table fell into my hands, prevented the possibility of my analyzing it as I could have wished: I am, therefore, compelled to confine myself to a mere explanation of its application, which I shall do in a solitary example; for as its results are confined to one particular spot, and as the

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(*) The arrangement of the Tables having accidentally been disturbed, the present one, which should have been the XXIXth, is the XLVIIth, of this collection.

(†) The Sungscrete word for Terrestrial Longitude is *Desentara;* and for the Celestial *Sayana.*

object of the present research is general, I shall, in the remainder of what I have to say on the *Vakiam* process, have recourse to those general methods, which though more operose, may be applied to any geographical position on the globe.

The Equations furnished by the Table under consideration (which is the 4th of the *Vakiam* process) are to be applied to the Moon's uncorrected place, such as it has been elicited by her *Druva*, and *Chandra Vakiam P'hala.*

Application of the Desentara calas.

The *Desentara* calas or minutes, registered in the second column, are always additive, and to be taken for the month which *precedes* that for which the computation is made.

Of the Andra vicalas.

The *Andra* vicalas, or odd seconds, registered in the third column, are for *any day* in the month itself that the computation is made for. They are to be used as multiples of the odd degrees, minutes and seconds of the Sun's true place, at Sun rising on the proposed day; the product of the degrees giving *vicalas*, or seconds; that of the minutes, *tarparies* or thirds, and so forth, which implies a division by 60′.

This latter Equation is to be applied ± to the Moon's uncorrected place, as indicated in the Table.

EXAMPLE.

Let the Sun's apparent place on the 24th Audi *complete*, be - - 3^s 22° 59′ 3″

And the Moon's uncorrected place at the same instant - - 4 3 57 13

1° Add the Desentara calas for *Auni* II, - - - + 7 0

2° The Andra vicalas, for any day in Audi ♋ (the month computed in) are + 2″, and the odd degrees, minutes, &c. of the Sun's Longitude - 22° 59′ 3″

Multiply by × 2

Equation 45″ 58‴ 6⁗

And on account of the 58‴ say - - - - - - + 46

☽'s place corrected *for Desentara*, 24th Audi - - - 4 4 4 59

Moon's place corrected.

Of the Equation due to the difference between the Moon's true and mean motion.

Second correction supposed to answer to the Moon's Arca Bhagábala.

There is a last Equation used by the Tamul Kalendar makers, of which *Sami Nada* could give me no other account, but that it was indispensable, and which I believe answers to the *Arca Bhagábala*, though the process for eliciting it, bears not the least resemblance to any of the methods that we have hitherto seen.

Difference of Moon's true and mean motions.

In the Example which I have selected, there were, after division of the *Ahargana* by the respective Elements, 9 *Devarams*, and the Chandra Vakiam Dhurmavanham was 100, for which, by Table XXVI, the Moon's true motion is - - - - - - 844′

Her mean motion being supposed to be - - - - 791

Difference 53

An Equation of 32″ per Devaram.

Now for each *Devaram* the precept directs an Equation of 32 tarparies or thirds; therefore 9 × 32″ = 288″, which product multiply by as many units as there are in the difference of the Moon's apparent and mean motion, and this second product, which amounts to 288″ × 53 = 4′ 14′ 24″, is to be applied ± to the Moon's place once corrected, as her *true* is greater than her mean motion; and *vice versa*.

Resolution of 2d correction.

Moon's place twice corrected.

In the present case it will therefore be

		S.	D.	M.	S.
☽'s place once corrected - - -		4ˢ	4°	4′	50″
Add Equation - - -	+			4	14
☽'s place twice corrected - -		4	4	9	13

supposed to be her *Sputa Graha*, or apparent place at the instant of Sun rising on the 25th of Audi, at the place computed for.

ARTICLE 3.

Resolution of the last conjunction of the year 4923 of the Cali yug, reduced to a given Meridian.

Resolution of the *Amavasya* which ended the 4923d Luni-solar year of the Cali yug, called *Brisya;* and preceded the commencement of the 4924th called *Chitrabhanù*, reduced to the Meridian of Trivalore, as is supposed.

A

We have found at pages 119 and 120, that the Solar and Luni-selar *Ahargana*s, with the respective *Soota dina* for the end of the 4923d year of the Cali yug, were,

	D.	G.	V.	P.
Solar Ahargana, 1st Chaitram 4924 - -	1798166	20	12	30
Luni-solar do. 30th Phalguna 4923 - - -	1798147			
The Solar Soota dina consequently - -	Thursday.			
The Luni-solar do. - - - -	Friday.			

1° Divide the Lunar Ahargana successively by - 1 Vedam 1600984)1778147(1

```
                                                   1600984
                                                   -------
1 Raza Gherica  -  -  -  -                   12372)197163(15
                                                   12372
                                                   -----
                                                    73443
                                                    61860
                                                    -----
1 Calanilam  -  -  -  -                       3031)11583(3
                                                    9093
                                                    ----
1 Devaram  -  -  -  -                          248)2490(10
                                                    248
                                                    ----
Chandra Vakiam Dhurmavanham  -  -  -                 10
```

the Argument of Table XXVI.

2° Multiply the analogous Longitudes by the respective quotients; viz.

1 Vedam	7^{s}	2°	$0'$	$7''$	× 1	7^{s}	2°	$0'$	$7''$
Raza Gherica	9	27	48	10	× 15	4	27	2	30
Calanilam	11	7	31	1	× 3	9	22	33	3
Devaram	0	27	44	6	× 10	9	7	21	0
☽'s Druva						6	28	56	40
Equation for Chandra Vakiam 10 (Table XXVI)						4	7	58	0
Moon's place uncorrected						11	6	54	40

Moon's place uncorrected.

at the time of Sun rising at Lanca, on the 11th Poongoni ending, or 12th commencing; to be rectified hereafter.

B

For the Sun's place.

We find by the Solar Ahargana given at Article A, that the Sun entered the Sign Mesha ♈ when there had expired since the beginning of the Cali yug - 1798166^{d} 20^{g} 12^{v} 30^{p}

Subtract abstract duration of the month Poongoni, Table III,	— 30	20	21	2
Ahargana, 1st Poongoni 4923	1798135	59	51	28

Ahargana 1st Poongoni 4923.

which shews that the Sun entered the Sign Min ♓ at night time; and that there remained to complete the night, and begin the day (60^{g} — 59^{g} 51^{v} 28^{p}) 0^{g} 8^{v} 32^{p}; which according to the precept delivered at page 123, article 3°, are to be added as *vicalas* and *tarparies* to the signs and degrees of his Longitude, in order to have that Element precisely for the time of his rising. Then to proceed,

Sun's Saura place, 1st Poongoni	11^{s}	0°	$0'$	$0''$
For 11 days complete		11	0	0
Add for 8^{v} 32^{p}, or say 9^{v}				9
☉'s Saura place on the 12th Poongoni at his rising at Lanca	11	11	0	9

Sun's place uncorrected.

which to reduce to his apparent Sydereal place according to the precepts delivered at pages 119 and 120, we have by Table XXVII, part 1st, for the first 8 days in Poongoni — 2′; for the ensuing 8 days (from the 9th to the 17th) — 4′; and $\frac{4'}{8}$=30″ for one day; and from the 8th to the 11th there being 3 days, say 3×30″=1′ 30″; which added to 2′, gives — 3′ 30″ for the Equation sought; and as only $9''$ were added to the Sun's Saura place on account of what remained of the night when the Sun entered the Sign Min ♓, the second Equation adverted to at page 125, para. 3, is insensible. Hence

☉'s Saura place above found	11^{s}	11°	$0'$	$9''$
Subtract Equation		—	3	30
☉'s Sputa Graha, or apparent place at Sun rising at Lanca on the 12th Poongoni A. C. 4923. (*)	11	10	56	39

Sun's place corrected.

(*) As far as this step, the rule is the same whether we work for the Arca Bhagábala by the 2d part of Table XXVII, or by the rule delivered at page 128, or if we mean to find the Sun's true motion on the day computed for by Table XXVII or XXVIII, because these Elements have nothing to do with the preceding part of the operation.

To correct the Moon's place for the Desentara and other Equations.

Reductions to the Longitude.

By Table XLVII, the *Desentara* calas for the month preceding that of Poongoni (page 131) i. e. Maussi, are +26′.

The *Andra* vicalas by the same Table for Poongoni itself are — 10″; and the odd degrees, minutes, &c. of the ⊙'s Longitude are - - - 10° 56′ 39″

Which according to precept multiply by - - - × — 10

— 1′ 49″ 20‴ - - 109″ 20‴ 30⁗

For the last Equation (page 125), the Moon's true motion due to Vakiam 10, Table XXVI, is 829′; but the Sun's apparent place is - - - 11ˢ 10° 56′ 37″

And the Moon's (uncorrected) - - - - 11 6 54 6

which shews that on the 12th at Sun rising, the conjunction had *not* occurred; therefore by precept, page 124, her motion is to be taken for the next Vakiam day, viz. 11, the motion for which is - - - - - - 840′

☽'s mean motion - - - - - . 791

Difference 49

Last Equation answering to the Arca Bhagábala.

But the operation (page 132) shewed 10 *Devarams* in the Ahargana, to each of which, 32‴ are due: therefore 10×32‴=320‴, which product drawn into the difference 49, gives 320‴×49= 4′ 21″ 20‴, and because the Moon's *true*, is greater than her *mean* motion, that Equation is additive.

For the Moon's corrected place and distance.

☽'s uncorrected place (page 127) - - -	11ˢ	6°	54′	6″
Add Desentara calas - - - -			26	0
And last Equation - - - - -			4	21
	11	7	21	27
Subtract Andra vicalas - - - -		—	1	49
☽'s Sputa Graha, or corrected place - - -	11	7	22	38
⊙'s do. do. - - - - -	11	10	56	39
⊙ and ☽'s distance, 12th Poongoni, at ⊙ rising -		3	34	1

For the relative motion.

Moon's place corrected.

☽'s Sputa Gati, Table XXVI, .	840′	0″
⊙'s do. do. Table XXVIII, .	59	23
Relative motion, 12th Poongoni .	780	37
or	13° 0′	37″

For the end of the Tidhi or time of conjunction.

True time of conjunction.

Say: 13° 0′ 37″: 60ᵍ :: 3° 34′ 1″: 16ᵍ 26ᵛ 59ᵖ,

the time after Sun rise on the 12th when the conjunction occurred.

With a view to establish the difference in the time of conjunction which would result from computing the same by means of an *Ahargana* (or sum of days) greater by one day than that which was obtained from the Elements of the Ariah Siddhanta, I have computed the Ahargana for the same conjunction as it would be by the Elements of the Surriah Siddhanta (Table XLIX, part 1), which is 1798148', being *one day more* than that which we have used in the preceding computation. Now if we divide this new quantity by the four Elements, the remainder in days, or *Chandra* Vakiam, will be 11, instead of 10 that it was before; which 11 days used as the Argument of Table XXVI, for the Moon's Equation, and true motion, and then following the process to the end, as has already been shewn, will give only a difference of $1^{v}\ 42^{p}$ in minus, in the ultimate result; (*) the reason of this being, that if one day more be taken in the Ahargana, you compute necessarily the Sun and Moon's apparent places for the morning *after* the conjunction; in consequence of which, at the end of the operation, you have to deduct the time due to the Sun and Moon's distance from 60 guddias, supposed to mark the time of Sun rising.—Whereas if you compute with one day less, you will find the Sun and Moon's apparent places in the morning *before* the conjunction, and therefore the time due to their distance must be *added*, instead of *subtracted*, to that of Sun rising on the day computed for. It is therefore immaterial which of the two Ahargaoas, by the Ariah or Surriah Siddhanta, are used in the Vakiam process.

ARTICLE 4.

The same conjunction computed for Lanca.

In the preceding Article I have shewn how the Sun and Moon's apparent places, their distance and time of conjunction are to be determined by certain Tamul Tables constructed for a particular spot in the Peninsula, which I conceive to be Trivalore. But as there should be a specific Desentara Table for every Meridian which is not that of Lanca, and as the object of this research is general, I shall dispense in future from using Table XLVII; and (excepting in the last example of all, where I propose resolving the time of the expunged month which will fall on the 5065th year of the Cali yug, reduced to the Meridian of Madras) all the rest of the computations will stop at *Lanca*. With a view to uniformity I shall therefore recompute the last operation from the point where it ceased to be common to all places, and by means of Table XXVII, determine the time of the last conjunction of the Luni-solar year 4923, as it would be reckoned at Lanca.

We have found at page 133, that the Moon's uncorrected place at Sun rising on the 12th Poongoni of the said year, at Lanca, was - - -	$11^{s}\ 6^{\circ}\ 54'\ 40''$
And the Sun's (page 133) - - - -	11 10 56 39

(*) The quantity elicited by the last proportion, which is the time due to distance, was 43g. 34v. 18p.

60

Time of Amavasya by Vakiam 11 - - - - 16 25 42 which on account of his presence, and the comparative slowness of his motion, the Tamuls never correct for the difference of Longitude nor his Arca Bhagábala. The last quantity is therefore, considered as his true or apparent place on the proposed day.

The Sun's Equation, diurnal motion, and Moon's Arca Bhagábala computed by means of Table XXVII, p. 2.

But there remains to apply the Moon's Arca Bhagábala to her uncorrected place, even for Lanca; and in order to be independent of Table XXVIII, which though sufficiently true for present time and for a great number of years past and to come, yet in process of time will be affected by the change in the position of the Sun's Apsis, we shall compute the Sun's diurnal motion as well as the Lunar Arca Bhagábala by means of Table XXVII, part 2.

That Table gives the Argument of the Sun's Equation on the 1st Poongoni,	+ 2ˢ 12° 42′ 40″
☉'s mean motion for 10 days, Table XX,	9 51 22
for 1 do.	59 8
Manda Kendra, or Argument, on the 11th Poongoni complete	2 23 33 10
or	83 33 10

with which referring to Table XXIV, we find his Anomalistic Equation 2° 9′ 44″, marked additive in Table XXVII, part 2, and for the reasons given at page 127.

The Lunar Arca Bhagábala is therefore . . $+\frac{2^{\circ}\ 9'\ 44''}{27} = +\ 4'\ 48''$ (*)

With regard to the Sun's diurnal motion, the same Argument of Anomaly referred to the same Table XXIV, will give the Equation of the Sun's true to his mean motion 13″; which as the day computed for falls before the 18th Poongoni, is still marked additive . . 59′ 8″

	+ 13
The Sun's true motion on the 12th current is therefore	59 21

For the Moon's corrected place and her distance from the Sun at his rising on that day.

True distance.

☽'s uncorrected place	11ˢ 6° 51′ 40″
Her Arca Bhagábala	+ 4 48
☽'s apparent place sought	11 6 59 28
☉'s do.	11 10 56 39
Distance	3 57 11

For relative motion.

☽'s Sputa Gati	14° 0′ 0″
☉'s do. do.	59 21
Relative motion sought	13 0 39

(*) The Equation found at page 134, supposed to correspond to this, was + 4′ 21″.

For time due to distance.

Say $13^{g}\ 0'\ 39''$: 60^{g} :: $3^{g}\ 57'\ 11''$: $18^{v}\ 4'\ 23^{p}$

the end of the Amavasya Tidhi after Sun rise at Lanca.

True time of conjunction.

The same was found for a different place in the preceding article . 10 20 59

Difference 1 37 31

The end of the 30th Tidhi of the Lunar month Phalguna of the year 4923, occurred therefore on the 12th of the Solar month Poongoni of the same year; and the *Prathama Tidhi* or first of the Lunar month Chaitram of the year 4924, on the 13th of the same month of the Solar year 4923.

Registering of the last Amavasya Tidhi of A. C. 4923 and of the *Prathama* Tidhi of 4924.

Q. E. In.

The same conjunction computed by the Siddhanta process, was found to occur on the same day at $16^{g}\ 14^{v}\ 25^{p}$; the difference of the result is therefore $1^{g}\ 50^{v}\ 5^{p}$ and in European time $44'\ 2''$, a difference easily accounted for by the dissimilarity of the processes, and of the Elements used in each method. Nor is it to be believed that there may be found a greater degree of coincidence in the computations of different Tamul Astronomers, though using equally the Solar process; for independently of the Tables known to them all, they contrive others for their own private use, both for general and local purposes, which do not always agree; and occasion quarrels among them, which their ignorance of theory renders generally interminable.

Article 5.

Resolution of the two Amavasya Tidhis which determine the Cshaya *or expunged month in a double intercalary year.*

Resolution of the two Amavasyas which determine a Cshaya month.

In order to save a number of useless trials of years and months on which the discarded Lunar month may fall, I shall shew in the 3d part of this Memoir, how the Hindus foretel that accident, by computing the time when the Moon's Apogee lies in one of the Signs of the Solar Zodiac which corresponds to any of the three shortest Solar months of the year, and also when a mean *Adigah*, or Lunar intercalary month is due, in a particular Solar month where it *cannot* be introduced. For it will be seen, that the first of these cases is to be expected when the Moon in Apogee is in the same sign, degree, &c. as the Sun in Perigee; and the second when the Moon in Perigee coincides with the Sun in Apogee; and the probability of either occurring, is greater or less in proportion to the degree of coincidence of these Elements.

Indication when a Cshaya month will occur.

The same of an Adigah month.

In the present article I shall be contented with the common trial of the three Cycles of 19; 141; and 160 years; and as the second is always the most probable one, considering that the last Cshaya occurred when the 4782d year of the Cali yug had expired (A. D. 1681 and 1603 Saca), I shall conclude that the next must fall when 4923 years of the Cali yug have elapsed; and lastly, as the month of *Margali* (Bengal *Paushia)* in the present position of the Sun's Apsis, is the shortest month of the Solar year, I shall try the time of the two conjunctions, which may fall near to its beginning and end.

Resolution of the 1st Amavasya which determines a Cshaya month.

I.

For the first Amavasya.

A

The respective Aharganas for the beginning of Margali will be obtained as follows:

	4923 *Lunar.*	4921	*Solar.*
Aharganas 30th Phalguna	1798147	1st Chaitram	1798166 20 12 30
Add 9 Lunations	265 46	Add number of days to the end of Cartiga (*)	246 18 37 10
	1798412[46		1798412 [38 49 40
	1		1
Aharganas sought	1798413	2d Margali	1798413

Here the two Aharganas are alike, but of the *Sootu dina* after division by 7, the remainder for that of the Sun must be counted from *Friday*, and that for the Moon from *Thursday*: Hence the 2d Margali falls on *Saturday*, and the nearest Amavasya, on *Friday*, which by the Kalendar will be found to fall on our 13th of December (page 119).

B

For the Sun's Anomalistic Equation and Moon's *Arca Bhagábala*, proceeding as in the preceding article, and with reference to Table XXVII, we shall find that the Sun's distance from his Perigee on the 2d Margali was 16° 18′ 12″, and by Table XXIV his Equation — 37′ 14″.

The Moon's Arca Bhagábala is therefore $-\frac{37' \, 14''}{27} = -1' \, 22''$.

C

The Moon's *Druva* will be - - -	7ˢ	26°	40′	46″
The Chandra Vakiam 28; and its Equation, Table XXVI,	0	8	26	0
	8	5	6	46
Lunar Arca Bhagábala (B) - - -			— 1	22
☽'s Sputa Graha on the 1st Margali - -	8	5	5	24

complete, or 2d commencing at Sun rise at Lanca.

And Moon's true motion, Table XXVI, 722′ or 12° 2′.

D

The Sun on the 1st Margali enters his 8th Sign (Kalendar, page 119) at	38g	47v	40p
	60		
Time to run to 2d Margali commencing - - -	21	10	20

which guddias and viguddias, because the month began at night time, are to be added to his *Saura*

(*) Vide Table XLVIII, part 2d.

place, as *calas* and *viculas*. Hence, after applying the usual Equation of Table XXVII, part 1, for $21^g\ 10^v\ 20^p$, which is $26''\ 27^x$, the Sun's Sputa Graha at Sun rise at Lanca on the 2d Margali, will be $8^s\ 0^\circ\ 21'\ 36''$; and by Table XXVIII, his true motion $61'\ 23''$.

E

For the Sun and Moon's distance.

2d Margali at Sun-rise at Lanca.	☉'s Sputa Graha (D)	8^s	0°	$21'$	$36''$
	☽'s do. do. (C)	8	5	5	21
Soob-vi-Arca Indoo Graha		0	4	43	48

F

For relative motion.

☉'s Sputa Gati (D)	1°	$1'$	$23''$
☽'s do. do. (C)	12	2	0
Soob-vi-Arca Indoo Gati	11	0	37

G

For time due to distance.

The rule will be as before $\frac{60 \times 4^\circ\ 43'\ 48''}{11^\circ\ 0'\ 37''}$ and the time due to distance $25^g\ 46^v\ 27^p$, and because the Moon was more advanced than the Sun in the Zodiac, the above result shews the time elapsed at Sun rise on the 2d Margali since the conjunction had occurred; therefore, from - 60^g

Subtract	25	46^v	27^p
True time of Amavasya	34	13	33

after Sun rising on the 1st of Margali.

H

But it appears by the Solar Kalendar, page 119, that the Sun entered the sign Dhanus ♐ on the same day, at

	38^g	49^v	40^p
	34	13	33
End of the 30th or Amavasya Tidhi	4	36	7

before the Sydereal commencement of the Solar month Margali, when the Sun was therefore still in the sign Vrischica ♏; that is, in the Sydereal month Cartiga, although the *Civil* Margali had begun.

I

Since the *Amavasya* Tidhi of the Lunar month *Cartiga* fell on the 1st Margali Sydereal account, at *night time*, it is to be coupled with *that* Solar date; and the *Prathama* Tidhi of the ensuing Lunar month *Margasiras* (if any such month were to be counted in the year 4924 of the Cali yug) should correspond to the 2d Margali. But by the Kalendar, page 119, the Sydereal Solar month *Cartiga* counted 29 and the Civil 30 days, therefore the *Amavasya* under consideration, instead of the 1st Margali, must stand opposite to the 30th Civil day of *Cartiga;* and the *Prathama* Tidhi of the ensuing Lunar month, to the 1st Civil Margali, which was accordingly done in the Panchangum for that year (vide page 68). We shall see, however, presently, that the next Lunar month was not to be called *Margasiras*, but *Paushia*.

II.

For the second Amavasya or next conjunction, which must fall about the end of the Solar month Margali ♐ or beginning of Tye ♑.

A

Resolution of the 2d Amavasya which determines a Cshaya month.

Not to repeat unnecessarily what must now be familiar to the reader, I shall state that if one Lunation be added to the last Lunar Ahargana, and the absolute duration of the month Margali, as given in Table III, to the last Solar one, the respective Aharganas, now required, will be, viz.

the Lunar 1798442, and the Solar - - -	1798441^{d} [59^{r} 42^{r} 41^{p}
and therefore that to be used for the Moon's *Druva* and Chandra	+ 1
Vakiam - - 2d Tye 4924, is - -	1798442

The Solar *Soota dina* will therefore be *Sani-vara*, Saturday, the 11th January 1823; and the Lunar, *Sucra-vara*, Friday, 10th.

B

For the Sun's Anomalistic Equation and Lunar *Arca Bhagábala,* it must be observed on referring to Table XXVII, part 2, that passing from *Margali* to *Tye*, the Sun has entered the third quadrant of his Anomaly; and consequently, that the Argument of his Equation, though still referred to his Perigee, is now increasing, from decreasing that it was before. In computing the *Manda Kendra*, we are therefore to take from Table XXVII, part 2, 1st *Tye* 12° 42′ 40″

☉'s mean motion in one day - - - -	+	59 8
Manda Kendra, 2d Tye - - - - -		13 41 48

which by Table XXII gives, ☉'s Equation — 30′ 29″; and consequently the ☽'s *Arca Bhagábala* — $\frac{30' \; 29''}{27} = 1' \; 7''$.

C

For the Moon's apparent place at Sun rise on the 1st Tye complete, or 2d at Sun rise, the Chandra Vakiam will be 57.

Her Druva - - - - -	7^{s} 26° 40′ 46″
And the Equation of Vakiam 57 - - -	0 28 58 0
	8 25 38 46
From which subtract *Arca Bhagábala* - -	— 1 7
☽'s Sputa Graha, 1st *Tye* complete - -	8 25 37 39

and by the same Table XXVI, her true motion or Sputa Gati 726calas, or 12° 6′.

D

For the Sun's apparent place on the 2d Tye at his rising, we see by the Kalendar, page 119, that he completed his 9th Sign and entered Macara ♑, at

	59^g	42^v	41^p
	60		
	0	17	19

which shews *night* time; therefore the *vicalas* and *paras* are to be added to his Saura place, and are 17′,3.

At the expiration of the 1st of Tye or at Sun rising on the 2d, the Sun has therefore only gained 17″ in his 10th Sign, and the ☉'s Sputa Graha is $9^s\ 0^\circ\ 0'\ 17''$ (*), and by Table XXVIII the Sun's true motion on the 2d Tye is $61'\ 23''$ or $1^\circ\ 1'\ 23''$.

E

For the Sun and Moon's distance.

2d Tye at Sun rising at Lanca	☉'s Sputa Graha (D)	9^s	0°	$0'$	$17''$
	☽'s do. do. (C)	8	25	37	39
Soob-vi-Arca Indoo Graha			4	22	38

F

For the relative motion.

☉'s Sputa Gati (D)	1°	$1'$	$23''$
☽'s do. do. (C)	12	6	0
Soob-vi-Arca Indoo Gati	11	4	37

G

And for the time due to distance.

$$\frac{60 \times 4^\circ\ 22'\ 38''}{11^\circ\ 4'\ 37''} = 23^g\ 42^v\ 35^p.$$

and as the Moon was less advanced than the Sun, the above quantity marks the time *after Sun rise* when the conjunction was to occur.

H

By the Kalendar, page 119, the Sun entered the Sign Macara ♑ on the 1st day of the Solar

month Tye, at	59^g	42^v	41^p
	60		
that is, *before* Sun rise on the 2d		17	19
Now the Amarasya occurred (G)	23	42	35
after Sun rise.	23	59	54

(*) Here, as the fraction is only 17″, the Equation by Table XXVII, part 1, is insensible.

adding therefore these two quantities, we find that the conjunction occurred 23^g 59^v 54^p, after the Sydereal beginning of the Solar month *Tye.*

I

By the first part of this article, the conjunction near the beginning of Margali ♐ fell 4^g 36^v 28^p *before* the Sun entered the Sign Dhanus ♐ (page 139), and by the second part, the *Amavasya* which was to occur about the beginning of Tye ♑ took place 23^g 59^v 54^p *after* he had left it (page 141). Hence there was *no conjunction* during the time that the Sun was in the Sign Dhanus ♐; in consequence of which the *name* of one of the Lunar months, (which in the present case is *Margasiras*) is to be *passed over;* and that which follows the Solar month *Cartiga*, (viz. *Paushia*), is to be used. In the Panchangum, however, it is customary to write the names of both; annexing the word *Cshaya* thereto. Thus we find in the Kalendar of A. C. 4924, page 68, for the month under consideration, *Cshaya Margasiras Paushia.*

How in that year the Lunar month *Cartica* happened to correspond with the Solar *Cartiga*, and occasioned *Paushia* to answer to *Margali*, will be explained in the next article.

I shall close these observations by a remark of Audy Sashaya, which I give in his own words.

"As it is customary in the first instance to compute the general *Adigah*, and *Cshaya* months, "such as these would occur at Lanca, which is supposed to have neither Latitude, nor Longi- "tude, the results of such computations must be considered as indispensable approximations, "without which, the problems could not be resolved.

"But when afterwards computing the Kalendar for any particular place, where there is of "course Latitude and Longitude, there may sometimes be both an *Adigah* and a *Cshaya* at "*Lanca*, and none at the proposed place.

"When there is a great difference of time between the commencement of the Solar month, and "the preceding conjunction, then the *Adigahs* and *Cshayas* will be the same all over India; but "in the contrary supposition, when that interval is but small, the case may be otherwise."

ARTICLE 6.

Resolution of the two Amavasyas which determine the first intercalation due to the year 4924 of the Cali yug.

Resolution of the two Amavasyas which determine an Adigah month.

If the order of the times were followed, this article should have preceded that which treats of the expunged month of the same year, for in the case of a double intercalation the first *Adigah* month always precedes the *Cshaya.*

But it will be shewn in the third part of this Memoir, that the first indication of a *Cshaya* is that a mean Adigah month will fall in any particular year, on a month where it cannot possibly be inserted, because the Solar month happens to be shorter than the Lunar one. The *Cshaya* is therefore the accident which draws with it the double intercalation, and prepares us for the same, and on that account it was entitled to the precedence.

As it generally occurs that when the Cshaya falls on *Margasiras*, the first Adigah due in the same year occurs in the Solar months which answer to the Lunar *Aswina* and *Phalguna*, and which are *Paratasi* and *Poongoni*, I shall now proceed to the resolution of the two changes which affect the former.

Resolution of the first Amavasya which determines an Adigah month.

For the Aharganas.

	4923 Lunar.	4924	Solar.
Ahargana 20th Lunar Phalguna	1798147	☉ 1st Chaitram - -	$1798166^{d}\ 20^{g}\ 12^{v}\ 30^{p}$
Add 6 Lunations - -	177	Time to run to the last day of Auvani, Table XLVIII, p. 2.	156 26 44 6
	1798324	Ahargana 1st Paratasi -	1798322 [46 56 36
			+ 2
		Ahargana 3d Paratasi at Sun rise	7)1798324(256903 remainder 3

which remainder 3 being counted from Friday, gives the *Soota dina*, *Soma-vara* (Monday); and as we have added 2 days to the Ahargana of the 1st Paratasi, the computation will be for the 3d at Sun rising.

Resolution of the 1st Amavasya in Paratasi.

Having found that the Sun entered the Sign *Canya* ♍ on the 1st Paratasi at $46^{g}\ 56^{v}\ 36^{p}$ after Sun rise (Kalendar, p. 119), and that the Ahargana to be used was 1798324^{d}, I shall briefly state, that the Chandra Vakiam is 187; the Moon's Arca Bhagâbala — 4′ 40″; her Druva $6^{s}\ 28^{\circ}\ 56'\ 40''$, its Equation $10^{s}\ 8^{\circ}\ 52'\ 0''$, and the Sun's Equation — 1 40 (Table XXVII). The respective Longitudes at Sun rise on the 3d Paratasi, will therefore be,

3d Paratasi, at Sun rise at Lanca	☉'s Sputa Graha - - -	$5^{s}\ 1^{\circ}\ 11'\ 23''$
	☽'s do. do. - - - -	5 7 44 0
	Soob-vi-Arca Indoo Graha - - - -	0 6 32 37

The relative motion by Tables XXVI and XXVIII.

☉'s Sputa Gati - - - -	53 26
☽'s do. do. - - - - -	13 3 0
Soob-vi-Arca Indoo Gati - - - -	12 4 34

The time due to distance is therefore $\frac{60\times6^{\circ}\ 32'\ 37''}{12\ 4\ 34}$ - - $32^{g}\ 30^{v}\ 42^{p}$

and as the Moon was more advanced than the Sun, it shews that the conjunction had passed, and that the time above found is to be retrenched from that of Sun rising on the 3d Paratasi, when the 2d is completed.

	$60^{g}\ 0^{v}\ 0^{p}$
	32 30 42
Time of conjunction on the 2d after Sun rise - -	27 29 18

	G.	V.	P.
Now the Sun entered the Sign Canya ♍ on the 1st Paratasi, at	46	56	36
	60	0	0
After Sun rise ; there remained therefore from that instant to the 2d	13	3	24
And the time of conjunction being on the 2d after Sun rise, at	27	29	18
The Amavasya took place - - - -	40	32	42

after the Sun's entrance into the new Sign, when 40^{g} 32^{v} 42^{p} had elapsed.

Second Amavasya.

Resolution of the 2d Amavasya which determines an Adigah month in Paratasi.

When two successive conjunctions are to be determined, the Hindu computers contrive to abridge the process by omitting to consider the *Ahargana*, and working for the Sun's place, by adding the absolute duration of the following Solar month to the fractional part, in guddias, viguddias, &c. of the time of beginning of the month elapsed. This gives the Sydereal end of the month to be worked for: but as the Sun and Moon's apparent places are wanted for the time of Sun rising, the excess of time over a complete day (which in Solar computations is always the instant referred to) is to be retrenched from the entire Sign, *if the preceding morning be wanted*: but its complement to one degree is to be added if the *end* of the same day be required.

A particular method for shortening the process,

In the same manner they avoid computing again the ☽'s *Druva*, by considering first what the *Chandra Vakiam Dhurmavanham* was at the last conjunction; then adding thereto the number of complete days resulting from the addition of the duration of the absolute month to the fractional part spoken of at the beginning of this article, and subtracting the number of days that may have been added to the beginning of the month for reaching the Lunar *Soota dina*, the remainder gives the *Chandra Vakiam*, or Argument sought. And secondly, considering that the Moon's Druva varies only once in a *Devaram* or 248 days, they conclude that having only added 29, 30, or 31 days to the original *Ahargana*, it may not have increased during that interval, on which they proceed, being certain that the result will prove whether the assumption has been a right or a wrong one.

As the process here adverted to has not yet been presented to the reader, I shall compute the second *Amavasya* more in detail than I otherwise should have done.

A

	D.	G.	V.	P.
The fractional part of the last Solar Ahargana (page 143) was -		46	56	36
The absolute number of days in the Solar month Paratasi, Table III, is	30	27	22	1
Epoch of Sun's entrance into the Sign Tula ♎ - -	31	14	18	37

which therefore began at day time, so that the guddias and viguddias are to be subtracted as calas and vicalas from the Sun's Saura place; but as on the 1st Arpesi the Equation given in Table XXVII, part 1st, is only 1' in 8 days, it is insensible in the present case, being only 1″, and may be neglected. The Sun's Longitude at Sun rise of the 1st Arpesi, will

therefore be	6^s	0°	0′	0″
Subtract the guddias as calas —	0	0	14	18
☉'s Sputa Graha sought	5	29	45	42

and by Table XXVIII his true motion is 59′ 44″ on the 1st Arpesi.

B

The Sun's Anomalistic Equation by Table XXVII, part 2d, will be found —2° 7′ 25″; and the Lunar Arca Bhagábala — $\frac{2° \; 7' \; 25''}{27}$ — —4′ 43″

C

For the Moon's Druva, Chandra Vakiam; and apparent place.

The Chandra Vakiam found for the last conjunction (page 143) was	187^d
To which add the number of entire days found at article A	31
	218
But 2 days had been added to the Solar Ahargana for equating it to the Lunar one, which subtract —	2
Chandra Vakiam for the present operation	216

Now as we have only added 31 days to the *Ahargana* (or *Paratiái*), the Vakiam of which was 187 days, we may suppose that the Moon's Druva has not changed; we take it therefore as at page 143.

☽'s Druva	6^s	28°	56′	40″
Add Equation due to Vakiam 216	11	0	21	0
	5	29	17	40
Subtract Moon's Arca Bhagábala —			4	43
☽'s Sputa Graha, 1st Arpesi	5	29	12	57

and her true motion, Table XXVI, 761 calas, or 12° 41′.

D

For the Sun and Moon's distance.

2d Arpesi at Sun rise at Lanca	☉'s Sputa Graha (A)	5^s	29°	45′	42″
	☽'s do. do. (C)	5	29	12	57
	Distance	0	0	32	45

E

Relative motion.

☉'s Sputa Gati (A) - - - - -	$0^{\circ}\ 59'\ 41''$
☽'s do. do. (C) - - - - -	12 41 0
Relative motion - -	11 41 16

F

For time due to distance.

$$\frac{60\times 0^{\circ}\ 32'\ 45''}{11^{\circ}\ 41'\ 16''} = 2^{g}\ 48^{v}\ 6^{p},8 \text{ after Sun rise.}$$

G

We have found at article A, that the Sun entered the Sign Tula ♎ on the 1st Arpesi after Sun rise, at - - - - - $14^{g}\ 18^{v}\ 37^{p}$

And by the last article F, that the conjunction took place also on the 1st, after Sun rise, at - - - - - 2 48 7

There wanted therefore - - - - - 11 30 30

$11^{g}\ 30^{v}\ 30^{p}$ of time when the Amavasya occurred, for the Sun to enter the Sign Tula ♎; he being then still in Canya ♍.

CONCLUSION.

Conclusion.

The first Amavasya took place on the 2d Paratasi (page 144) $40^{g}\cdot 32^{v}\ 42^{p}$ after the Sun had entered the Sign *Canya* ♍; and the second, or that of the ensuing Lunar month, when there wanted $11^{g}\ 30^{v}\ 30^{p}$ of his entrance into the Sign *Tula* ♎, from which it follows that two conjunctions occurred during the time that the Sun was in *Canya* ♍, and therefore, the name of the Lunar month *Aswina*, which concurs with the Solar *Paratasi*, must be repeated, calling it *Adigah* the first time, and *Nija* the second.

It would be a misapplication of time and labour to give the further resolution of the second intercalation, which in the 4924th year of the Cali yug, (or the 1745th from the birth of Salivahana) occurred during the Solar month *Poongoni*, and fell on the Lunar *Phalguna*, called *Phalguna Mitick*, or Adigah Chaitra; so that in the said Luni-solar year there were two *Chaitras*, and no *Margasiras*. The process for both intercalations is in every respect the same, and (as far as I am able to judge) requires no further illustration.

I shall, therefore, close here my researches into the Astronomical part of the Luni-solar Panchangum, which by some classes of readers will, I have no doubt, be deemed unnecessarily extended. I declare, however, that I long, but vainly endeavoured to reduce these two parts of the second Memoir to a narrower compass. Whatever I attempted to retrench, left a chasm which I was compelled to fill again, because it interrupted the course of argument, prevented the exposition of certain ingenious methods intended to shorten the process, and in some cases deprived the reader of the opportunity of useful references.

NOTE.

Note on the specific name given to each Hindu year, whether Solar or Luni-solar.

I have already stated that it is an invariable practice throughout India, to call each Solar and Luni-solar year by the name of that of the Cycle of 60 years to which it corresponds; a custom which may prove of great resource in Chronological researches. As there will be found in this collection a separate Tract which treats especially of the three different modes according to which the years of the *Vrihaspati Chacra* are computed in different parts of India, I shall only advert here to two very short practical Rules which elicit the name due to any proposed year, either according to the precepts of the Surriah Siddhanta, or to the Tellinga account, both of which are given in the General Tables at the end of the Volume.

I.

According to the Surriah Siddhanta.

Precept for the name of the Chacra year according to the Surriah Siddhanta and Tika.

" Divide the numeral of the proposed year by 86; add the quotient to the dividend; divide the
" sum by 60, and the quotient will give the number of cycles expired since the beginning of the
" Cali yug; and to the remainder, if the proposed year be less than 31 from the last expunged
" year of the *Chacra* (to be found in Table XVIII), add 28; but if the said year falls in the
" 55 remaining years of a cycle of 86 years, add 27; and the remainder so increased will indicate
" the numeral of the year current of the Chacra, and consequently its appropriate name."

(For an Example, see page 214).

II.

The same according to the Tellinga account.

Precept for the name of the Chacra year according to the Tellinga account.

" Divide the years expired of the Cali yug by 60; the quotient will give the number of
" cycles expired, and the number of units in the remainder counted from *Pramathi*, the 13th
" of the Chacra, as *one*, will give the name of the last Vrihaspati year expired, and the following
" one that of the year sought.

EXAMPLE.

Example.

Let the name of the same year of the Cali yug 4924, be wanted according to the Tellinga account.

$$
\begin{array}{rl}
 & 60)\,4923\,(82 \\
 & \quad\;\; 120 \\
\cline{2-2}
\text{remainder} & \quad\quad\; 3
\end{array}
$$

which counted from *Pramathi* as *one*, gives *Brisya* for the name of the last expired, and *Chitrabhanú*, the 16th of the Chacra, for that of the current one.

Although I have taken notice of some of the *Astrological* articles and ephemerides in the description which I have given of the Siddhanta Chandra Panchangum at the beginning of this Memoir, yet I shall not attempt to analyze any of them before dismissing it. But if the reader be curious in these matters, he may collect valuable information on the *Yoga*, *Carna* and *Isharum*, on referring to the commentary which follows the present tract.

N. B.—I was told by the Madras Sastras that the Luni-solar year, which is chiefly used in Bengal, is the *Bhanu Husputtia Chandra Mana*, the months of which, considered as secondary, are called *Gauna*, in contradistinction to *Múkya*, the name given to those of the *Siddhanta Chandra Mana*, which are primary, the former beginning with the *full Moon* instead of the new Moon which precedes the commencement of the Solar year. As I have sometimes found the Carnatic Pundits and Sastras misinformed on matters of Bengal usages, and customs, and particularly on those which depend on Hindu Astronomy, they may also be mistaken in this statement; but it is a point which may be easily settled in Calcutta. Be this as it may, however, as I find it stated in several books that the *Bhanu Husputtia*, differs in no respect, but in the time of its beginning, from the *Siddhanta Mana* (as it is called on this Coast), the same principles and rules which were disclosed in this Memoir, will serve equally for the construction of the above mentioned Luni-solar year.

PART III.

On the Hindu method of determining the mean Epochs of Intercalation.

Although Hindu Astronomers seem never to have been much in the habit of foretelling celestial Phœnomena for remote times, yet (as we have already seen) they are in no respect deficient in means for calculating with a certain degree of accuracy, the occurrences which depend on time for any Epoch whatever.

The manner of intercalating the Lunar months being an article of the first importance in the construction of the Panchangum, the rare and unequal recurrence of double intercalations with a consequent expunged month, made them consider how these circumstances might be anticipated with a tolerable degree of certainty and without that expenditure of time and labour, which loose trials by the Siddhanta rule, must necessarily occasion. This attempt naturally suggested the resolution of the mean Epochs when from the combined revolutions of the Sun and Moon these Equations were due. They seem first to have attended to the relative motion of the two Luminaries, and then proceeding more scientifically to those of their Apogee, they concluded that when the Moon in Apogee coincided with the Sun in Perigee, it necessarily occasioned a simultaneous short Solar, and long Lunar month; lastly, they discovered that when the Moon's Apogee was in about fifteen degrees of either of the Signs *Vrischica* ♏, *Dhanus* ♐ or *Macara* ♑, (which for many ages past are in possession of the Sun's Perigee), if a mean intercalation was due about the middle of the corresponding Solar month, it was *impossible* that the Epoch elicited by their rules for intercalating should be the true one consistently with their own theories.

For since each of the three Solar months *Cartiga*, *Margali* and *Tye* are now shorter than a mean Lunation; and since the Moon when near her Apogee has a slower *apparent* than *mean* motion, it is manifest that under such circumstances neither of the three aforesaid short Solar months could contain two changes of the Moon.

The same consideration must have also led them to discover that when there was no change in either of the said short Solar months, then there were two new Moons in two other months of the same year (or to be more precise, a double change in one of the six preceding, and another in one of the six following months), occasioning thereby two intercalations where only one could be admitted. They appear then to have taken a hint from nature, and agreed to suppress the month on which no conjunction occurred: thus preserving, with apparent metaphysical consistency, both the general theorem, and that Equation of one Lunar month *only* which was sufficient for keeping the commencement of the Luni-solar year, within its accustomed distance, from that of the Solar one.

If we consider well the nature of their Chronological doctrines, we must admit that, under the force of circumstances, they could not adopt a less arbitrary measure; for it depends more upon nature (though much less to the purpose) than our bissextile intercalations, and is less exceptionable than the irregular, and indefensible duration of our months.

Such, after an attentive consideration of the doctrine of Lunar intercalations, appears to me the origin of the theory and practice of a method which has no doubt led to the discovery of the three Cycles of 19, 141, and 160 years, in either of which a double intercalation must recur.

ARTICLE 1.

The resolution of mean intercalations by the Hindu rule.

Mean intercalations. Let it be proposed to determine whether an intercalation be due to the 4924th year of the Cali yug current.

Rule. 1º Reduce the proposed years into mean or *Saura* months.

4923×12=59076 Saura months.

Then say, as the number of Saura months in a Maha yug - -	51840000
To the number of Adigah months in the same - - - -	1593336
So the number of Saura months above found - - - -	59076
To the number of Adigah mouths sought $\frac{1593336\times59076}{51840000}$ - -	1815

with a remainder of 38317506.

Now from the divisor - - -	51840000
Subtract the remainder - - - -	38317506
Second remainder - - - - -	13522494

which second remainder divide by the number of Adigah months in a Maha yug.

1593336)13522494(8 months
Remainder 775806
Multiply by × 30
)23274180(14 days
Remainder 967476
Multiply by × 60
)58048560(36 guddias
Remainder 788464
Multiply by × 60
)47307840(29 viguddias
Remainder 1100096
Multiply by × 60
)66005760(41 paras
Remainder which need be carried no farther 678984

This result shews therefore, that a mean intercalation is due when 4923^y 8^m 14^d 36^g 29^v 41^p of the Cali yug have elapsed, referred to mean midnight at Lanca; and therefore, that the intercalation will fall in the 4924th year of the said æra; about the 15th Margali at 36^g 29^v after mean midnight.

Observing that the Hindus compute that the first intercalation that was due after the beginning of the Cali yug, fell when 2^y 8^m 16^d 3^g 55^v &c. had expired, I analyzed that proposition as follows:

The primary Epoch of intercalation accounted for.

The primary period of 2^y 8^m 16^d 3^g 55^v &c. may be reduced to this expression in months and parts, 32^m,5355104008 &c.: Hence by the Hindu formula we have $\frac{1593336 \times 32,5355104008}{51840000} = 0$.

The numerator being equal to 51839999,99 &c. or 51840000, which shews that at the above *primary* period (2^y 8^m 16^d 3^g 55^v 7^p,39 &c.) there was precisely an intercalation due; and from this cause at every succeeding period a meao intercalation recurs.

Account of Table XXIX.

Account of Intercalary Table.

After what has been said, the Table of Intercalations is easily explained; the only thing to be remarked is, that the additional 7,39 paras are neglected in its construction.

This Table, however, is subject to an additive Equation or *Cshepa* of 3^v 50^v which remains unexplained.

EXAMPLE I.

Application.

Let it be proposed to determine whether the year Cali yugam 4924 current be subject to an intercalation.

			Y.	M.	D.	G.	V.
By Table XXIX, part 3, for 1898 years		- - - - -	1897	10	25	41	40
		Multiply by				×	2
		(1)	3795	9	21	23	20
		Part 3 -	948	11	12	50	50
Indices.	Assumed *Druva* for succeeding years	(2)	4744	9	4	14	10
4923		Part 2 -	170	4	22	6	45
Sub. (1) 3795							
1178 Take the nearest in the Table.		(3)	4915	6	26	20	55
		Part 1 - (4)	8	1	18	11	45
4923							
Sub. (2) 4744			4923	8	14	32	40
179 do. do. do.		*Cshepa* -		+		3	50
4923			4923	8	14	36	30
Sub. (3) 4915			4923	8	14	36	29,6
(4) 8 do. do. do.		Difference insensible					0,4

EXAMPLE II.

For the year 4782.

For the year 4782 by the Tables.

Here, in order to save trouble we may start from the nearest year already expounded.

Which being 4744 (Example I) we take any Epoch already expounded, which call *Druva*

	Y.	M.	D.	G.	V.	
Druva - - -	4744	9	4	11	10	(Example I).
Part II, - -	37	11	14	51	50	
	4782	8	19	9	0	
Cshepa, or Equation -			+	3	50	
	4782	8	19	12	50	

which quantity is the same as that produced by the Hindu rule.

EXAMPLE III.

For the year 5064.

For the year 5064 by the Tables.

We may commence with the Epoch of 4923, elicited in Example I.

	Y.	M.	D.	G.	V.	
Druva - -	4923	8	14	36	30	(Example I).
Part II, - -	132	10	7	11	55	
	5056	6	21	48	25	
Part I, - -	8	1	18	11	45	
	5064	8	10	0	10	

Here we need not add the Equation, because it is already involved in the quantity which marks the Epoch of intercalation for the year 4923 (vide Example I).

Years when a month may be expunged.

In the three preceding cases we are to notice the same circumstance, namely, that each indicates the intercalation to be due on the 9th month (or 8th complete) of the respective years, which falling on the Solar month Margali (one of the 3 short ones and when the Sun is in the Sign Dhanus ♐), indicates that the order of *true* intercalations is interrupted (page 149); and as in the three cases, the days on which the mean one is due, are not remote from the middle of the month, if the Moon's Apogee should lie about that time somewhere near 15° of the Signs *Vrischica* or *Dhanus* (♏ and ♐), the Hindus conclude that there must be two intercalations with an expunged month, in the years Cali yugam 4782, 4923 and 5064.

We shall shew presently how that Element may be expounded without having recourse to the endless Rule of the Surriah Siddhanta.

Years which are not intercalary how found.

The preceding Rule and Tables, may serve equally to determine what year is a common one; for if by adding any number of the periods given in the Table we do not elicit the proposed one, then it is certain that it is neither an Adigah nor a Cshaya year.

EXAMPLE IV.

Let it be required to know whether the year Cali yugam 4781 be an Adigah year?

Then proceeding as before.

	Y.	M.	D.	G.	V.
Example II and Table XXIX,	4741	9	4	14	0
Part 3,	18	11	22	27	25
Do.	16	3	6	23	30
Do.	2	8	16	3	55
	4782	8	19	9	10
Equation			+	3	50
Epoch, giving 1 year too much	4782	8	19	13	0

and as in the present case we could not take a lesser period out of Table IX than 2^y 8^m 16^d 3^g 55^v (the next above zero), it is clear that the proposed year 4781 is a common *Sumvat-saram*, or year of 12 Lunar months.

ARTICLE 2.

To find the mean place of the Moon's Apogee by the Tables.

I shall now proceed to shew how the place of the Moon's Apogee for any Epoch not ascending beyond the year Cali yugam 4399 complete (A. D. 1297) may be ascertained by means of Table XXI, as accurately as if it had been computed by the Siddhanta process.

Rule of Vavilala Cuchinna for finding the *Ahargana* from the year 4399 complete of the Cali yug, as an Epoch called the Index in his process.

This method, which is supposed to have been devised by Vavilala Cuchinna, an Astronomer said to have lived at the above Epoch, presupposes the knowledge of a Rule contrived for eliciting a sum of days in lieu of the Ahargana, which serves as an Index to all the Tables of the author referred to.

This Rule differs little from the common one in point of form, for like all these that we have hitherto seen, it is performed with the universal instrument the *Trirasica*; only that in order that the results may always be the same as if they had been computed from the origin of the Cali yugam, we are to add 85211 before division by 180,000, and subtract 3875864 before division by 13358334: Precept.

RULE.

To find the sum of days which will serve as an Index to the Table, for the year Cali yugam 4923. Rule.

As 4923 years of the Cali yug ended on the 12th of the Solar month Poongoni at midnight at Lanca, say 4923

Epoch 4399

Number of years elapsed 524

For the Index and initial feria $\frac{66389 \times 524 + 85211}{180,000} = 193$ Adigah months.

$$\begin{array}{r} 524 \\ 12 \\ \hline 6288 \\ +\ 193 \\ \hline \end{array}$$

Number of Lunar months elapsed 6481

$$\frac{6270568 \times 6481 - 3875864}{13358334} = 3041 \text{ Cshaya Tidhis.}$$

	6481
	30
	194430
	— 3041
Index. Sum of days or Index - -	191389 (*)
	7)191389(27341
Remainder	2

which, as in the case of the Tellinga rule, is to be counted from *Thursday*, and therefore we have, as before, *Sani-vara* (Saturday) the initial feria of the Luni-solar year 4923.

For the mean place of the Moon's Apogee by the Tables on the beginning of the year.

The *Druva* or mean place of the Moon's Apogee, for the last day of the 4399th year of the

Cali yug was - - - - -	4ˢ 15° 26′ 17″
The Bijah, or correction due to the same - - -	1 29 1 (+)
The motion of the ☽'s Apogee in 1 day - - -	6 40 59‴

With these data proceed as follows; the Index being 191389 days.

For the Moon's Mandocha.

100000 - - - -	11ˢ	8°	17′	27″	44‴
90000 - - - -	10	4	27	42	57
1000 - - - -	3	21	22	58	29
300 - - - -	1	3	24	53	33
80 - - - -		8	54	38	17
9 - - - -		1	0	8	48
191389 - - - -	2	17	27	49	48
Druva - - - -	4	15	26	17	0
And as the Rule and Druva are adapted for the preceding noon -	7	2	54	6	48
Add semi-diurnal motion of the Apogee - -		+	3	20	29
	7	2	57	27	17
The same by the Siddhanta process, (p. 84) - -	7	2	57	26	12
	Difference			1″	5‴

Correction of Bijah for 4 Revolutions in a Maha yug.

100000 - - - - -			4′	55″	52‴
90000 - - - - -			4	26	17
1000 - - - - -				2	58
300 - - - - -					53
80 - - - - -					14
9 - - - - -					2
191389			9	26	16
Equation due to Druva - - - -		1°	29	0	54
		1	38	27	10
Mean place of the Moon's Apogee - -	7ˢ	2	57	27	17
Corrected place	7	4	35	54	27
The same by the Siddhanta process (p. 86) - -	7	4	35	53	22
For the Prathama Tidhi of the year 4923. Difference				1″	5‴

(*) This process is the same as that which is used for finding the Index to the Table of the Planets for computing their mean places.

(+) Table XXI.

But we want the place of the Moon's Apogee for 8m 14d 36g 30v later + the remainder in the month of Poongoni 4923 from the time of the Luni-solar date of the beginning of the Chandra year.

Now by Table III the absolute month of Poongoni contains	-	30d	20g	21v	2p
From which subtract	-	12			
		18	20	21	2
For 8 Solar months complete	-	275	39	30	11
	+	14	36	30	0
Number of days elapsed	-	308	36	21	13

And for the motion of the Moon's Apogee due to the same.

Table XXI - 300 days	-	1s	8°	24′	52″	33‴
8	-			53	27	50
30 guddias	-			3	20	29
6	-				40	48
Bijah for 300 days	-					53
		1	4	22	23	33
Place of the ☽'s Apogee, 1st Chaitram 4924	-	7	4	35	54	27
Corrected place of the Moon's Apogee	- -	8	8	58	18	0

at the time when the intercalation was due.

Mean place of the Moon's Apogee on the proposed day.

Thus we have expounded that important Element by a comparatively short process, and with as much accuracy as if we had used the Sastra Rule.

Now observing that an intercalation was due on the 15th day of the 9th month of the year 4923 (8m 14d complete) and that at the same instant the Moon's Apogee was in 8° 58′ 18″ of the Sign Dhanus ♐, corresponding with the Solar month *Margali* (one of the three short ones of the Solar year), whereas the Sun's Perigee was in 17° 17′ 18″ of the same Sign Dhanus (*), there can be no doubt, from their near coincidence, that *no two conjunctions* can occur in the said month *Margali;* and that the Luni-solar month corresponding thereto is a *Cshaya*, or expunged month, and not an *Adigah.*

Conclusion for an expunged month in the year 4924 of the Cali yug current.

The same circumstance may be argued, and the same results obtained for the years 4782 and 5064 *complete*, a notation which it is always necessary to keep in view when considering Hindu expressions; because the intercalation truly falls in the years Cali yugam 4783, and 5065 *current.* But as the Indians invariably make their computations for the *end* of the years, as well as of the Tidhis, those which their notation presents, imply always the year or Tidhi which has *last expired;* the fractional part of the quantities belonging to the ensuing ones.

The same for 4783 and 5065 current.

5063.

But if we come to convert the years so expressed into European time, then as the new Hindu year generally commences (as it has done for many centuries past) during the first months of the European concurring years, the intercalations and omissions, mostly fall in the course of the *same Christian year.*

In reading the columns of the second General Table, if we seek the character of the Hindu year

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(*) The Sign Dhanus being the 9th current, the Perigee is in 8s 17° 17′ 17″ 54‴ because the Sun's Apogee was at that time in 2s 17° 17′ 15″ 54‴ (vide page 23).

Notation of the Adigah and Cshaya years in the IId General Table.

which falls opposite to A. D. 1822, and which happens to be A. Cali yugam 4923, we are therefore to understand that the latter *ended* in 1822, and being marked AC in the fith column, that the intercalation and omission fall in 4921 *current;* but that notwithstanding the change in the notation of the Hindu year, these Equations are still introduced during the course of A. D. 1822. It must be acknowledged that this method of noting a year by its end, instead of its commencement, is somewhat incommodious, and liable to occasion mistakes; but it could not be altered without departing from the manner of computing of the Indians, which in matters that concern them and their Tables we are bound to preserve.

Such is the preparatory method used by Hindu Almanac makers for approximating the recurrence of the Adigah and Cshaya months, before entering into the actual computation of the same. It might have been curious to ascertain what is the greatest distance of the Solar Perigee from the Lunar Apogee necessary to cause an expunged Lunation; but I am not aware that this research would lead to any useful purpose. That circumstance occurs very rarely, and as the Indians in their approximations (besides their calculating the place of the Moon's Apogee) resort also to the probable evidence of the Cycles of 19, 141 and 160 years, I shall leave the resolution of that problem to those who may be curious in abstract speculations, the limits of certainty being sufficiently narrowed by the foregoing two rules for all practical purposes.

19, 141 and 160 years, the three Cycles in which a Cshaya year may recur.

I shall close this Memoir by giving a last and complete resolution of the Cshaya year and months which are to occur at the period nearest to our times, by all the *short* rules which have been disclosed in the course of it. For this purpose we must begin by constructing the Skeleton of the Solar Kalendar for the year 5065 current (*) (A. D. 1963), as was done for A. Cali yugam 4924 current, which fell 141 years before; but as some of the articles are constant, all that we require now, is a Table of the Initial Roots of, and duration, of its months, which are variable. Dominical Letter A. D. 1963, F. Dominical Letter A. D. 1964, ED.

Skeleton of the Solar Kalendar for the year 5065 of the Cali yug current.

European dates of beginning of Solar months	Names of Solar months.	Initial Roots of months.	Sydereal duration of months	Civil duration of months.	Names and order of Zodiacal Signs.	Types of Signs.	Signs current.	Signs complete.
14 March	Poongoni 5064	(4) 28 17 43			Min	♓	12	11
13 April	Chaitram 5065	(6) 48 38 45	30	31	Mesha	♈	1	0
14 May	Vyassei	(2) 44 10 46	31	31	Vrisha	♉	2	1
15 June	Auni	(6) 8 22 47	32	31	Midhuna	♊	3	2
16 July	Audi	(2) 45 0 48	31	32	Carcata	♋	4	3
17 August	Aurani	(6) 13 12 50	32	31	Tinha	♌	5	4
17 Septem.	Paratasi	(2) 15 22 51	31	31	Canya	♍	6	5
17 October	Arpesi	(4) 42 44 52	30	31	Tula	♎	7	6
16 Novem.	Cartiga	(6) 36 51 53	30	30	Vrischica	♏	8	7
16 Decem.	Margali	(1) 7 15 55	30	29	Dhanus	♐	9	8
15 January	Tye (A.D. 1964)	(2) 28 8 56	29	29	Macara	♑	10	9
13 February	Maussi	(3) 55 24 57	29	30	Cumb'ha	♒	11	10
13 March	Poongoni	(5) 43 48 58	30	30	Min	♓	12	11
13 April	Chaitram 5066	(1) 4 10 0	31	30	Mesha	♈	1	0

(*) Vide Part III, Article I, Introduction.

ARTICLE THE LAST.

Resolution of the double intercalation with an expunged month which is to occur at the nearest period to present times, reduced to the Geographical position of Madras.

By the Vakiam Tables and Solar process.

Although the present article contains no new doctrine, but merely applies to a particular case those which have already been disclosed, yet after due consideration of the expediency of retrenching it from the body of this work on that score, I have suffered it to remain as a document which predicts a remote contingency; the only one of its kind that can possibly occur before 140 years have revolved. What follows may therefore interest the philosophers of the twentieth century, if these imperfect but elaborate pages live to that extent of time.

The Rule for determining the Epochs of mean intercalations given at page 152, has warned us that a mean intercalary Lunar month will be due in the ninth month of the 5065th Solar year of the Cali yug (1886 Saca); and as on the beginning of that year the Sun's Apogee will lie in $2^s\ 17^\circ\ 17'\ 34''$ of the Hindu Sydereal Zodiac; and as the Ayanamsa on the 1st Chaitram of the same year (13th April 1963) will be $21^\circ\ 51'\ 19''$, the said 9th month, (that of Margali) will still be one of the three short months of the Solar year. The Lunar intercalation which is due at that time, cannot therefore be introduced in that specific month, particularly if the Moon's Apogee happens then to lie near the middle of any of the three Zodiacal Signs *Vrischica* ♏, *Dhanus* ♐, or *Macara* ♑.

The Rule for intercalating announces an *Adigah* in the 9th month of the 5065th year of the Cali yug.

The 9th month of the said year still one of the 3 shortest months.

Having computed that Element by means of Vavilala Cuchinna's Index and Tables, as shewn at page 153, and found it to lie, on the 10th Margali 5065, in $7^s\ 11^\circ\ 36'\ 9''\ 12'''$; and the precise time of mean intercalation above referred to, being $5064^y\ 8^m\ 10^d\ 0^g\ 10^v$; knowing also that the Sun will complete its 8th Sign on the 1st Margali, we may conclude from these joint considerations, that the Lunar month which will happen to coincide with that of *Margali* instead of an *Adigah*, will on the contrary be a *Cshaya* month.

The Moon's Apogee in $7^s\ 11^\circ\ 36'\ 9''$ on the 10th Margali.

On this supposition if we proceed according to the Vakiam process, we shall find the following Elements.

SECTION I.

The Solar Ahargana on the 1st Margali 5065, by the Ariah Siddhanta (Table XLVIII, part 2) is $1849914^d\ 7^g\ 15^v\ 55^p$, and the Lunar, at the expiration of the 9th Lunation of the corresponding Luni-solar year, by the Surriah Siddhanta (Table XLIX, part 1) 1849914. The *Soota dina* or initial feria of the Solar month Margali is *Soma-vara*, or *Monday* (Kalendar, page 156).

Elements of 1st conjunction at the end of Caliga.

1st Margali 5065 at Sun rise at Lanca.	⊙'s apparent place	7^s	29°	$52'$	$54''$
	His true motion		1	1	23
	☽'s apparent place (her Chandra Vakiam being 2; Druva 7ˢ 4° 28′ 3″; Equation 0ˢ 24° 9′ 0″; and Arca Bhagábala — 1′ 27″)	7	28	35	36
	Her true motion		12	6	0
	⊙ and ☽'s distance		1	17	18
	Relative motion		11	4	37
	And the time due to distance		6^g	58^v	17^p.

And as the Sun at his rising at Lanca will be more advanced than the Moon, the last result indicates the time that will be wanting of the instant of conjunction at that moment, and shews that the *Amavasya* will occur after Sun rising.

	G.	V.	P.
But the Sun (Kalendar, page 156) will enter the Sign Dhanus ♐ on the 1st Margali, after its rising, at	7	15	55
From which subtract time of *Amavasya*	6	58	17
Time before the commencement of the Sydereal Solar month	0	17	38

Time of conjunction before the commencement of the Sydereal month Margali.

So that the Amavasya will take place at Lanca, not in the Solar Sydereal month *Margali*, but on the last Sydereal day of *Cartiga*.

SECTION II.

Second Amavasya.

After having added to the foregoing Solar Ahargana, the absolute duration of the Solar month *Margali*, as given in Table III, the Solar Ahargana will be 1849943ᵈ 28ᵍ 8ᵛ 56ᵖ; but as in the present position of the Sun and Moon's Apogees the Lunar Synodical, is longer than the Solar month *Margali*, we are to add one day more thereto, and the Ahargana to be used will be 1849944 corresponding to the 2d Tye 5065, which, proceeding as usual, will be found to fall on a *Wednesday* or *Bhuda-vara.* But it will be more expeditious to dispense with the Ahargana, and use the short process indicated at page 147. By either way, however, the Elements for the 2d Amavasya will be found to be as follows:

Elements of 2d conjunction in the beginning of Tye.

On the 2d Tye 5065 at Sun rising at Lanca.	⊙'s apparent place	9^s	0°	$32'$	$35''$
	His true motion		1	1	23
	☽'s apparent place (the Chandra Vakiam being 32; her Druva, the same as for the preceding month, 7ˢ 4° 28′ 3″; Equation 1ˢ 27° 30′ 0″; and Arca Bhagábala — 1′ 7″)	9	1	56	56
	Her true motion		12	28	0
	⊙ and ☽'s distance		1	24	21
	Relative motion		11	26	37
	And the time due to distance		7^g	22^v	10^p

As the Moon is more advanced than the Sun, the last quantity shews the time that will be elapsed at Sun rise since the conjunction has taken place.

	G.	V.	P.
Therefore from - - - -	60		
Subtract	7	22	10
End of Amavasya Tidhi, 1st Tye, after Sun rise at Lanca -	52	37	50

	G.	V.	P.
But it appears by the Kalendar, page 156, that the Sun will enter the Sign Macara ♑ on the 1st Civil day of Tye, after Sun rise, at -	28	8	56
If therefore we retrench this time from that of the Amavasya -	52	37	50
	24	28	54

Time of conjunction after the Sun has entered the Sign Macara ♑.

we have the time elapsed between the Sun entering the new Sign, and that when the conjunction is to occur.

CONCLUSION.

No conjunction during the time that the Sun remains in the Sign Dhanus ♐.

Therefore the Lunar month *Margasiras* to be expunged out of the Kalendar for A. Cali yug 5065 at Lanca.

We have seen in the preceding article, that the last conjunction was to happen on the last Sydereal day of the Solar month *Cartiga* (page 158) at 17ᵛ 38ᵖ before the Sun entering the Sign Dhanus ♐, and by the present operation, that the ensuing one will fall 24ᵍ 28ᵛ 54ᵖ after he was to leave it; therefore it happens that no change will take place during the whole of the Solar Sydereal month Margali ♐, and that under the Meridian and Latitude of Lanca; the Luni-solar year 5065 will be a *Cshaya*, or double intercalary year.—From which we conclude, that as the Lunar month *Aswina* of the same year must in consequence be an *Adigah*, or intercalated month, (page 149); *Margasiras* (also called *Agrahayan*) which would concur with *Margali*, should be expunged out of the *Chandra Panchangum* for that place.

SECTION III.

The conjunction in Cartiga referred to the Meridian and Latitude of Madras.

Having now obtained the certainty that the 5065th year of the Cali yug is a *Cshaya* year for *Lanca*, we are to determine whether it be equally so for Madras; and for this we have the following

DATA.

Latitude of Madras or *Acsha Bagahs* (Table XXXIII) -		13°	4′	
Longitude of do. or *Desentura* (Table do.) in yojanas -			65	E.
Mean Time - -		47ᵛ	4ᵖ	E.
	Angulas.		Vinculas.	
Equinoctial Shadow or *Palabah* (Table XXXIV) -	2		47	
Ayanansa, 1st Margali 5065 (*) - - -		21°	58′	3″
☉'s apparent place at Sun rise at Lanca -	7ˢ	29	52	54″
True motion - - - -		1	1	23
☽'s apparent place at do. - - -	7	28	35	36
True motion - - - -		12	6	0″

(*) 141y × 54″ = 2° 6′ 54″. From 1st Chaitram to 1st Margali 275 days; and from Poongoni 11th to 30th, 19 days; therefore 275 + 19 = 294, and 365d : 54″ :: 294 : 44″. Hence

Ayanansa, 1st Chaitram 4924 - - - - -	19°	50′	25″
Cranti Patagati for 141 years - - - - -	2	6	54
294 days - - - -			44
Ayanansa, 1st Margali A. Cali yug 5065 -	21	58	3

N. B.—The same may be obtained much quicker by Table XXXV.

OPERATION.

The ☉'s true motion on the 1st Margali being $61'\,23''$, and the Longitude of Madras in time being $47^{r}\,4^{p}$ East, the Equation due to that interval of time is — $48''$, and consequently the Sun's apparent place at time of mean Sun rising at Madras is $7^{s}\,29^{\circ}\,52'\,6''$.

The ☽'s true motion on the same day being $12^{\circ}\,6'$, and the Longitude as before, the Equation due to the same is — $9'\,29''$, and the Moon's apparent place on the 1st Margali at time of mean Sun rising is $7^{s}\,23^{\circ}\,26'\,7''$. The ☉ and ☽'s true distance is $1^{\circ}\,25'\,59''$; the relative motion $11^{\circ}\,4'\,37''$, and the time due to distance $7^{g}\,45^{r}\,44^{p}$, which, because the Moon was less advanced than the Sun, marks the time wanting of the conjunction at mean Sun rising at Madras.

SECTION IV.

We are now to compute the time of true Sun rising at the proposed place on the said 1st Margali, so as to express the time of conjunction with reference to that instant; and for the resolution of that problem, we have recourse to what has been said in the second part of this Memoir on Hindu Gnomonics.

Although we have already given an example of the application of these doctrines when computing the end of the 30th or last Amavasya Tidhi of the year 4923 of the Cali yug, yet as other matters have intervened, one example more, of a rather intricate proposition, may not be superfluous for those who may be desirous of making further progress in Hindu Astronomy.

A

The Sun and Moon's places referred to the Tropical Sphere.

For the Ravi Sayana, or Sun's Longitude on the Tropical Sphere.

☉'s Sputa Graha, 1st Margali - -	7^{s}	29°	$52'$	$6''$
Ayanansa on the same day - -	+	21	58	3
Ravi Sayana, 1st Margali, at Madras - -	8	21	50	9

B

For the *Ullagna* of Madras, or Arc of the Equator which rises above the Horizon with the Sun, being what the Hindus call the *Sputa* or true quantity which determines the Sun's diurnal motion in oblique ascension.

Diurnal motion of the Sun in oblique ascension.

By article 59, Section II, Problems A and B of Gnomonics, page 104, we have

As 30° (1800 calas) to 1980 calas, (the Ullagna of Madras for 9 Signs, Table XLVI), So $61'\,23''$ (the Sun's true motion in Longitude), To $\frac{1980 \times 61'\,23''}{1800} = 67'\,30''$ the Sun's diurnal motion in *oblique ascension*, required.

C

For the length of the *Savan* or natural day.

We have already observed that as there are 216000 pranacalas (6 in a vicala) in a natural day, and the same number of calas (minutes of a degree) in the Equatorial Circle, or 360°; these 67 calas, 30 vicalas, represent *pranacalas in time*; therefore if we divide by 6, or $\frac{67'\ 30''}{6}$, we have 1st $\frac{67}{6}$ = 11 vic. 1 pra.; and 2d, 60 : 30″ :: 10 (castacalas) : 5. Hence the Equation sought is 11 vic. 1,5 pra. to be added to the *mean* Sydereal day.

The length of the Savan day required is therefore 60 dan. 11 vic. 1,5 pran. expressed in Murta time.

Length of the natural day in *Murta* time.

For the length of the artificial day or time of the Sun being above the Horizon on the 1st Margali 5065 current.

A′

The length of the natural or Bhumi Savan day being 60 dan. 11 pal. 1,5 pran., its fourth part, is 15 dan. 2 pal. 4,9 pran. (*) or $15^{g}\ 2^{v}\ 49^{p}$, being one half the *mean artificial day* and *night*.

The same in Solar time.

To have the true duration of each we are to find the Sun's Declination, or *Cranti Bagahs*, and Ascensional difference, or *Chara Cumda*.

B′

For the Sun's Declination (Gnomonics, Sect. II, para. 6º B, page 105).

The Ravi-Sayana (A, preceding page) -	8^{s} 21° 50′ 9″
The Sine of which is - - -	3402′
The Obliquity of the Ecliptic (constant) - -	24°
And its Sine or *Paramapa-Cramajya* - -	1397′

Then say

: Radius 3438 : Sine Sun's Longitude 3402′ :: Sine Obliquity 1397′ : $\frac{3402 \times 1397'}{3438}$ = 1382′ the Sine of the *Cranti Bagahs*, or Declination sought, corresponding to an Arc of 23° 43′ South.

The Sun's Declination.

C′

For the *Chara Cumda*, or Ascensional difference (Gnomonics, Sect. II, 6º C, page 105).

DATA.

	Sine.	Cosine.
The Altitude of the Pole is 13° 4′ its	777′	3348′
The Sun's Declination 23° 43′ South	1382′	3148′.

Say 1º (Cos. 13° 4′) 3348′ : (Sine Do.) 777′ :: (Sine 23° 43′) 1381′ : $\frac{1381 \times 777'}{3348'}$ = 320′, the *Cshetijya*, being the first approximation.

2º (Cosine 23° 42′) 3148′ : (Cshetijya) 320′ :: (Radius) 3438 : $\frac{320' \times 3438}{3148'}$ = 349′, the *Chara*, or Ascensional difference sought, which converted into time by Table XXXI, answer to $58^{v}\ 10^{p}$.

Ascensional difference.

(*) Because in a vicala or pala there are 6 pranacalas, and that in a viguddia there are 60 pana.

For the *Dinarda* and *Ratri-Arda*, or half the artificial day and night on the 1st Margali at Madras. (Gnomonics, Sect. II, 6º D, page 106).

A″

		G.	V.	P.
Because the Sun's Declination is *South*, from the fourth part of the natural day (A′, preceding page)		15	2	49
Subtract Chara in time (C′, preceding page)	—		53	10
Dinarda, or half artificial day		14	4	39
And for the night		15	2	19
Add Chara	+		58	10
Ratri-Arda, or half artificial night		16	0	49

B″

Artificial day and night.

The *Dina*, or entire day, is therefore $2 \times 14^g\ 4^v\ 39^p$	28	9	18
And the *Ratri* or entire night $2 \times 16\ 0\ 49$	32	1	38

C″

For the true time of Sun rising.

True time of Sun rising at Madras.

The time of noon is always expressed by		75	0	0
Subtract Dinarda		14	4	39
60 gud. + Equation of time, that of Sun rising at Madras on the 1st Margali		60	55	21
Add the whole Dina or artificial day		28	9	18
True time of Sun setting on do.		29	4	39

D″

It was found, page 160, that the conjunction will occur at Madras after *mean* Sun rise at		7	45	44
But the Sun rises truly on the 1st Margali at Madras after 60 guddias.(C′, present page)	—		55	21
Difference		6	50	23

Conjunction after true time of Sun rising, 1st Margali.

which shews that the Amavasya will fall at $6^g\ 50^v\ 23^p$ after *true* Sun rising at Madras, on the 1st Margali 5065.

E″

		G.	V.	P.
When the Sun entered the Sign *Dhanus* ♐, at Lanca (Kalendar, page 156), at		7	15	55
Add *Desentara* in time	+		47	4
It was mean time at Madras		8	2	59
Subtract Equation of time (C′)	—		55	21
Time of ☉'s entrance in ♐ after true Sun rising		7	7	38
Time of conjunction above found		6	50	23
Time before Sydereal commencement of Margali ♐			17	15
That which was found at page 158 (being computed for Lanca) was			17	38
Difference				23

Time of conjunction before Sydereal Beginning of Margali.

Second Amavasya.

Results of reductions of the 2d conjunction in the Solar month Tye.

The process being absolutely the same, I shall only give the results.

⊙'s Sputa Graha mean time of rising at Madras after accounting for the difference in Longitude of 47′ 4′ E. 2d Tye 5065	9ˢ	0°	31′	47″
☽'s do. do.	9	1	47	10
⊙ and ☽'s distance		1	15	23
Relative motion		11	26	37
		G.	V.	P.
Time of conjunction *before* Sun rising of 2d Tye		6	35	14
Or after mean Sun rise on the 1st do.		53	24	46
⊙'s motion in Oblique ascension		1°	4′	24″
		dan.	viealas.	pra.
The same reduced into *Murta* time			10	4,4
Duration of natural day at Madras in do.		60	10	4,4
Therefore ¼ the natural day;				

	d. c. pra.	dan.	vic.	pra.		G.	V.	P.
or ½ the artificial	$\frac{60\ 10\ 4,4}{4}$	15	2	4,1	or	15	2	41

The ⊙'s Declination		22°	3′
The *Cshetijya*			209
The *Charajya*			322
And the *Chara Cumda* in degrees		5	20
		V.	P.
The same in time by Table XXXI,		53	20
	G.	V.	P.
Hence the artificial day	28	18	42
the artificial night	32	12	2
Dinarda or half artificial day	14	9	21
Ratri-arda or half artificial night	16	6	1

From these results we come to the following conclusions.

	G.	V.	P.
The expression for noon time being always	75	0	0
And the *Dinarda* being	14	9	21
We have 60 guddias + the Equation of time for Sun rising	60	50	39
Add the whole *Dina* or duration of artificial day	28	18	42
Time of Sun setting after Sun rise on the 2d Tye	29	9	21

For time of conjunction after true Sun rising at Madras, on the 1st Tye 5065.

	G.	V.	P.
Time of conjunction after mean time of Sun rising on the 1st Tye 5065 (present page) at Madras	53	24	46
Equation of time, present page, subtract		50	39
Time of true conjunction after true Sun rise on the 1st Tye A. Cal. 5065 at Madras	52	34	7

Conclusion.

Conclusion.

	G.	V.	P.
By the Kalendar, page 156, the Sun will enter the Sign *Macara* on the 1st Civil day of Tye, at Lanca, after Sun rise, at -	28	8	56
Add Longitude in time . . . +		47	4
The same at Madras after *mean* Sun rising - -	28	56	0
Subtract Equation, preceding page - - —		50	39
	28	5	21
Which remainder subtracting from time of conjunction above found	52	34	7
Leaves the time of conjunction at Madras - -	24	28	46

after the Sun will have left the Sign Dhanus ♐ and entered Macara ♑.

The year 5065 of the Cali yug a Cshaya at Madras as well as at Lanca.

It appears therefore, that the 5065th year of the Cali yug will have two intercalary, and one expunged, months at *Madras*, as well as at *Lanca*, because the first conjunction under consideration will occur at that place 17^{v} 13^{p} before the Sun enters the Sign Dhanus ♐, and the second 24^{g} 28^{v} 46^{p} after he has left it, which was to be determined.

Observation.

Delalande complains somewhere, that although the science of Astronomy has appeared to the greatest men of all ages a study worthy to be followed through life, yet he was often compelled to answer the following question "Of what use is Astronomy?"

In the same manner, after having waded through a mass of theories and computations, the seeming object of which was merely to determine two circumstances to which the Hindu Luni-solar account of time is subject, I expect that many a reader will ask "Of what utility is so "long and fatiguing a research?" especially since it has been observed that (with the only exception of the country called *Tellingana*) the custom of dating documents by the *Tidhis*, has long since been abrogated in all parts of India; and that even there, a Luni-solar Tidhi is never proposed as a date, without annexing thereto the concurring Solar *Theidy*.

To which I shall answer, as the French Philosopher did, that to do away an error widely diffused, and to remove ignorance from any post which has influence over the concerns of men, must be practically useful in all times and countries. When several years ago I was called upon to look into the Tellinga Kalendar, so little was its construction understood, that the best informed Gentlemen with whom I conversed, even some who from inclination and habits were best acquainted with Hindu learning and usages, entertained a belief that I might invent some sort of perpetual Kalendar of the Siddhanta Chandra Mana, which would supersede the necessity of referring to the Native *Sastras* on any question of time, and answer all the common purposes of office. Nay, after the present Memoir had already assumed some consistency, a scientific friend objected that it was rather a Tract on Hindu Astronomy than on the Kalendar, and recalled my attention to the original design of the research: But after a perusal of all that he could collect on the same subject, he ultimately admitted (as I trust every person who has read with attention the preceding pages will) that any attempt to subject the contingencies of the Luni-solar years to any mechanical process, would be as hopeless a task as if it were proposed to elicit the articles of the English *Nautical Almanac*, or French *Connoissance des Tems*, by any other means than their regular computation.

One point has therefore been gained; namely, that of undeceiving several Gentlemen, well informed in other matters, on a subject respecting which they were much mistaken.

Lastly, if it be at any time of public importance to fix or expound dates according to Luni-solar account, having now disclosed the means by which these questions are resolved by the Native Sastras themselves, and (with the exception of a few particular contrivances invented by private Kalendar makers) *the only ones* that can answer the same end, I may be permitted to hope, that although the rules here given, be long and harassing in the extreme, yet the Key to the *Siddhanta Chandra Mana* has furnished an Instrument for Chronology which was hitherto unknown in this part of India.

END OF THE SECOND MEMOIR.

APPENDIX

TO THE

KEY TO THE SIDDHANTA CHANDRA MANA.

A COMMENTARY

ON

VAVILALA CUCHINNA'S

RULES AND TABLES FOR COMPUTING THE TELLINGA KALENDAR.

Written in the year 1797.

THE following Commentary on Varilala Cuchinna's Rules and Tables, is inserted here, rather as a Tract extremely remarkable, both for the singularity of the topics which it investigates, and for the ingenuity displayed in expounding them, than as an instrument which is likely to prove serviceable to the main object of these Memoirs. Such documents should be kept on record, although they be seldom referred to; because they may lead into unexpected discoveries, and teach better than any series of precepts, how to unravel the manner of reasoning of a people who have frequently found their way to truth by paths widely different from those usually followed by European philosophers.

It may be said of this Tract, that presented by itself, it would throw but little light on the theories of Hindu Astronomy. The contrivance of an arbitrary Index for using the Tables of the Planets, and other Elements, is in particular, calculated to throw a veil over the problems to be resolved, which nothing short of the penetration and perseverance of the scholiast who undertook the trying task of exploring them could ever have removed. But I trust that those who have perused the two first Memoirs of the *Kala Sankalita*, will find no difficulty in tracing back the rules contained in the following pages to their legitimate source.

⁂

RULES AND TABLES

For computing the principal articles of the Hindu Luni-solar Kalendar for the Meridian of Lanca reducible to any other Meridian, communicated to A. Scott, Esq. by Josela Barcarjosey of the Village of Satiaveram near Chicacole, in the year 1797. (*)

PART I.

1. On the last day of the Tellinga year which ended on the 28th March 1797 at noon, 4898 years of the Cali yug expired, and also 1719 years of the æra of Salivahana: the Epoch from which the computations commence is the end of the 1220th year of the æra of Salivahana, or 499 years before the commencement of the present Tellinga year. Epoch.

2. To find the number of days elapsed from the given Epoch to the beginning of the Tellinga year answering to the 28th March 1797 at noon. Ahargana from Epoch.

```
     1º                 2º                 3º             4º
     499                5988               5988           6172
      12                  86                184             30
    ----               -----              -----         ------
    5988                6074               6172         185160
      41                  15                               304
    ----               -----                            ------
 70)6029(86          33)6089(184                  708)185464(261
    6020                6072                          184788
    ----               -----                          ------
       9                  17                             676

        5º                        6º                  7º
        185160                    185160          7)182263(26037
           261                      2897            182259
        ------                    ------            ------
        185421                    182263                 4
            13
        ------
     64)185434(2897
        185408
        ------
            26
```

It appeared on consideration, that the number 6172 found by the 3d operation, is that of the

---

(*) The first part of this Tract refers to the XXXVIIIth, XXXIXth, XLth, and XLIst Tables.

Lunar months contained in 499 years; and that the number 182263 found by the 6th operation, is that of the number of days in the same period of years. The days divided by 7 shew that 26037 weeks had elapsed and four days over, and as the Epoch was on a Friday, the last day of the last Tellinga year fell on a Tuesday. From a consideration of the operations, I find that 385 years answer to 4762 Lunations, and that 7552 Lunations answer to 223015 natural days, without a remainder in either case. By combining these, it is found that 2907520 years answer exactly to 35962624 mean Lunations, and also exactly to 1061997430 natural days.

Ratio of the Sun's Zodiacal revolution to mean Lunation in the same.

It follows that one Zodiacal revolution of the Sun contains 12.3688312 mean Lunations; that a mean year or Zodiacal revolution of the Sun contains 365.2588563 days, that is $365^{d}\ 15^{g}\ 31^{v}\ 52^{p}\ 96$ as the Indians reckon, or $365^{d}\ 6^{h}\ 12'\ 45''\ 18$ as Europeans reckon; that one mean Lunation contains 29.5305879 days, that is $29^{d}\ 31^{g}\ 50^{v}\ 6.99$, or $29^{d}\ 12^{h}\ 44'\ 2.70$; and that one mean Zodiacal revolution of the Moon contains 27.3216747 days, that is $27^{d}\ 19^{g}\ 18^{v}\ 1.66$ or $27^{d}\ 7^{h}\ 43'\ 12''\ 66'''$.

Tidhis or Luni-solar days.

A Tidhi or the 30th part of a Lunation is on a medium equal to 0.9843529 of a day, or to $59^{g}\ 3^{v}\ 40^{p}\ 23$, so that 64 mean Tidhis are nearly equal to 63 days. It also appears that 34 mean Lunations or Lunar months are nearly equal to 38 Solar months or 12th parts of the Sun's revolution in the Zodiac. Since the last Tellinga year ended 28th March 1797 N. S. or 17th March O. S. at noon, and since 182263 days had elapsed from the Epoch to the end of last year, it follows that the Epoch answers to Friday the 14th March 1298; for 182263 days make 499 Julian years, including 125 Bissextiles, and 3 days over.

For the Prathama or Padyami Tidhi.

3. To find the mean time of the first Tidhi Padyami's beginning, or in other words the mean time of new Moon.

This is only a continuation of the computation at the beginning of the last article; by that the day of the new Moon was found, but this serves for finding the time of the day.

```
     10                    20
    676              64    0    0    0
     60              26   57   17   17
708)40560(57      64)37    2   42   43(0
   40356               60
    204             )2222(34
     60              2176
   )12240(17           46
    12036              60
     204             )2802(43
      60              2752
   )12240(17            50
    12036               60
     204              )3013(47
                       3008
                         35
```

The remainder left in the 4th operation of the last article is first reduced to sexagesimal parts, and joined to the remainder left in the 5th operation, of which it makes a part; as the quotient of the 5th operation is however subtractive in the 6th, its remainder including the fractional part, is first subtracted from its divisor 64, and then the difference reduced to sexagesimal fractions of a day. The result shews, that the time of the mean new Moon at the original Meridian, was the 27th March at $34^{g}\ 43^{v}\ 47^{p}$ after noon.

```
3º
80)75(0
    60
  ------
)4500(56
 4480
  ------
    20
     60
   ------
)1200(15
 1200
  ------
```

The method here used for finding the allowance to be made for the difference of Meridian, is equivalent to this proportion. As the circumference of the Parallel of Latitude or 4800 yojanas, is to a day or 60^s, so is 75 yojanas which we are to the Eastward of the original Meridian, to $56^v\ 15^p$.

Difference of Meridians.

```
        4º
34s  43v  47p
     56   15
-------------
35   40    2
```

The time of mean new Moon is therefore considered to have happened at the place where we now are, at $35^s\ 46$ [illegible] after noon of the 27th March.

Time of new Moon sought.

N. B.—It was often long before I could discover the objects which the following operations aimed at, and indeed I had gone thro' the whole method and seen to what purposes the computed numbers were applied, before I could form any conjecture about what was intended.

4. To find the number of mean Zodiacal revolutions of the Moon from the given Epoch to the beginning of the Tellinga year answering to the 23th March.

For the mean Zodiacal revolutions of the Moon from the Epoch.

```
        1º                        2º                       3º
      182263                    182263                   182263
          10 ×                     137                     2146
    --------                   -------                 --------
     1822630                    182400                   180117
        2300 +                      69 +                      1
    --------                   -------                 --------
13241)1825430(137           85)182469(2146           27)180116(6670
     1814128                    182410                   180090
    --------                   -------                 --------
       11002                        59                       26
```

The number 182263 is that of the natural days from the Epoch to the beginning of the present year, and when it had been discovered that the number 180116 in the 3d operation was Nacshatras, it was easy to find that the Moon is supposed to describe 556243 Nacshatras in 562870 days exactly. The mean time of the Moon's describing one Nacshatra is therefore $1^d.0119139$ or $1^d\ 0^s\ 42^v\ 53^p\ 39$. As 84 Nacshatras answer nearly to 85 days, it follows that if to a small Arc expressed in Nacshatras and sexagesimal parts, be added its 84th part, we have the time in which that Arc will be described, by the Moon, expressed in days and sexagesimal parts.

Having also discovered that the quotient 6670 in the 3d operation is that of the Zodiacal revolutions, it is easy to see that the Moon is supposed to complete exactly 556243 Zodiacal revolutions in 15197490 days; one Zodiacal revolution of the Moon is therefore equal to 27.32167416 days, that is $27^d\ 19^s\ 18^v\ 1^p\ 62$, or $27^d\ 7^h\ 43'\ 12''\ 65$.

For the Moon's mean place in the Zodiac at the beginning of the year.

5. To find the Moon's mean place in the Zodiac at the beginning of the year.

The computations in the last article shewed that the Moon had completed 6670 Revolutions and almost 26 Nacshatras over. The remainders left in those operations, are here reduced to sexagesimal fractions.

1°
11002
60
13244)660120(49
648956
11164
60
)669840(50
662200
7640
60
)458400(34
450296
8104

2°
59 49 50 34
60
84)3589(42
3528
61
60
)3779(44
3696
14
60
)874(10
840
34

If the second divisor had been 85, as in the last article, the quotient would have been sexagesimal fractions of a Nacshatra; but by dividing by 84 instead of 85, and thereby increasing the quotient, one 84th part, it follows from what was before remarked, that instead of the fraction of a Nacshatra, we get the time in which it is described. As this quotient is subtractive, it shews that in $42^r\,44^v\,10^p$ the Moon will complete the 26th Nacshatra at the original Meridian, and adding $56^v\,15^p$, (3) gives $43^r\,40^v\,25^p$ for the time after noon, at the place where we now are, of its completion.

For the number of mean periods of Yogas from the Epoch.

6. To find the number of mean periods of *Yogas* from the given Epoch to the beginning of the present Tellinga year.

1°
182263
7 ×
1275841
618 +
1238)1276459(1031
1276378
81

2°
182263
1031
181232
2 +
16)181234(11327
181232
2

3°
182263
11327
193590
3
27)193587(7169
193563
24

The number 193587 in the 3d operation being supposed the Nacshatras which the sum of the mean motions of the Sun and Moon amount to in 182263 days, I find that the sum of the mean motions of the Sun and Moon in 19808 days will be exactly 21039 Nacshatras. The mean time of a Yoga is therefore .9414896 of a day or $56^g\,29^v\,21^p\,75$, and 17 mean Yogas nearly equal to 16 days.

In 534816 days there will be 21039 mean revolutions or periods of all the 27 Yogas.

For the mean time when the 25th Yoga ends.

7. To find the mean time when the 25th Yoga will end.

By the last computation it appears that 24 Yogas were completed and the 25th begun.

```
     1o              2o
     81              16
      60              2
    ------          -----
1238)4860(3          14    3   55   32
     3714            60
    ------          -----
     1146         13)843(49
       60            833
    ------          -----
    )68760(55         10
     68090            60
    ------          -----
       670           )655(38
        60            646
      ------         -----
      )40200(32         9
       39516           60
      ------          -----
          684         )572(33
                       561
                      -----
                        11
```

The quotient 3 55 32 is properly subtractive from 2 the remainder in the second operation in the last article, but the complement of the whole to the former divisor 16 is here taken, because it is not the time since the 24th Yoga ended that is required, but the time until the end of the 25th Yoga. The dividing by 17 instead of 16 gives the second quotient 49^g 38^v 33^p in time, to which adding 59^v 15^p on account of Meridian distance, we get 50^g 34^v 48^p for the mean time of the end of the 25th Yoga after noon.

8. To find the number of Anomalistic revolutions of the Moon from the Epoch to the beginning of the present Tellinga year.

For the number of Anomalistic revolutions of the Moon from the Epoch.

```
     1o                    2o
   185160                555480
        3 ×                 146
   ------                ------
   555480                555626
      614 +                  49 +
   ------                ------
3784)556094(146       81)555675(6615
     552164              555660
     ------              ------
       3630                  15
```

The number 185160 on which this computation is founded, appears to be that of the Tidhis elapsed from the Epoch to the beginning of the year (art. 2, no. 4), and having found out that the quotient 6615 must be that of the Anomalistic revolutions of the Moon, it follows that 105952 Tidhis are equal to 3785 Anomalistic revolutions. One Anomalistic revolution of the Moon is therefore equal to 27.9926024 Tidhis, or 27.554600 natural days, that is 27^d 33^g 16^v 33^p 62 or 27^d 13^h 18′ 37″ 55‴.

9. To find the Moon's mean Anomaly, expressed in terms adapted to the Index of the Tidhi Table, for the mean time of new Moon.

For the Moon's mean Anomaly in terms of the Index of the Tidhi Table XXVII.

```
     3630
       80
    ------
3784)290400(76
     287584
    ------
       2816
         60
      ------
      )168960(44
       166496
      ------
         2464
```

The first remainder in the last computation is multiplied by 80, but the following fractions are sexagesimal parts of it. The quotient thus found is joined to the second remainder in the last computation, and gives 15 76 44 for the Index required.

Index of Tables for the Moon's mean Anomaly 15 76 44.

Each unit in the first term of this *Index* is the 84th part of one Anomalistic revolution of the Moon, or 328th of a natural day. Each unit of the second term being one 80th part of the first, is .041 of a natural day, or .246 of a guddia. To reduce guddias to the 246th part of a guddia, multiply by 4, and to the product add its 60th part. Thus if 15^v be given, then $4 \times 15 \times \frac{4 \times 15}{60} = 61$, and 61 : is to 15 :: as 1 : to 2.46 nearly. The reason of this remark will appear hereafter.

For the number of mean Anomalistic revolutions of the Sun from the Epoch.

10. To find the number of Anomalistic revolutions of the Sun from the Epoch to the beginning of this year.

```
        1o                    2o
      185160                185160
        1900 +                  32
      ------                ------
5720,187060(32              185128
      183040                    92 +
      ------                ------
        4020            371)185220(499
                            185129
                            ------
                                91
```

From this computation I find that 5719 Anomalistic revolutions of the Sun are supposed equal to 2122120 Tidhis, so that one Anomalistic revolution must be 371.0018714 Tidhis or 365.2587938 natural days; that is $365^d\ 15^z\ 31^v\ 39^p\ 48$ or $365^d\ 6^h\ 12'\ 39''\ 78'''$.

For the Sun's mean Anomaly for the mean time of new Moon in terms of the Index.

Index of the Solar Table XL ,90 2 59.

11. To find the Sun's mean Anomaly for the mean time of new Moon expressed in terms adapted to the Index of the Solar Table.

```
     4020
       10 ×
    -----
5720)40200(7
     40040
     -----
       160
        60
     -----
      )9600(1
       5720
       ----
       3880
```

The quotient is subtracted from the second remainder in the last computation, and leaves 90 2 59 for the Index required.

Each unit in the first term of this Index being the 371st part of one Anomalistic revolution of the Sun, or .9845 of a natural day; each unit of the second term will be .09845 of a day or 5.907 guddias. To reduce guddias to the scruples of time expressed by the second term of the Index, divide by 6, and to the quotient add its 60th part. Thus if 18^c be given, then $\frac{18}{6} \times \frac{18}{6\times60} = 305$, and 18 is to 3.05 as 5.902 to 1 nearly.

To find the Index to the Nacshatra Table XXXVIIC

12. To find the Index to the Nacshatra Table for the mean time of the Moon's completing the 26th Nacshatra.

```
      1o                      2o                       3o
43z  40v  25p          15   76   44             16   29   18
35   40    2                32   34                  62   20
-------------          --------------           -------------
 8    0   23       21)16   29   18(0 62 20      15   46   58
           4 ×         16   29    0
-------------          --------------
32    1   32                     18
     32    1
-------------
32   33   33
```

From the time of the Moon's completing the 26th Nacshatra (5) subtract the mean time of new Moon (3) which shews the former to be $8^z\ 0^v\ 23^p$ later than the latter. Multiply this difference by 4 and to the product add its 60th part (9), which gives 32 34 nearly for the increase answering to that time.

To the Index of the Tidhi Table for the mean time of new Moon (9), add the increase thus found, and it gives the Index of the Tidhi Table for the time of the Moon's completing the 26th Nacshatra 16 29 18.

The Index of the Tidhi Table being expressed in 84th parts of the circumference of a Circle and the Index to the Nacshatra Table being expressed in 80th parts of the same, the Index of th former must be diminished *four* 84th parts, or one 21st part, in order to adapt it to the latter Table.

This correction being made, gives 15 46 58 for the Index to the Nacshatra Table at the given time.

Index to the *Nacshatra* Table 15 46 58.

13. To find the Index to the Yoga Table for the mean time of the end of the 25th Yoga, or for 50g 34v 43p after noon (7).

To find the Index of the *Yoga* Table XXXIX 17 9 13.

```
    1°                  2°                     3°
50  34  48         15  76  44           16  57  23
35  40   2             60  39               31  50
----------         ----------           ----------
14  54  46      42)16  57  23(0 31 50   17   9  13
         4 ×       16  57   0
----------         ----------
59  39   4                 23
    59  39
----------
60  38  43
```

This computation is the same in principle with the last, only that as the Index to the Tidhi Table is expressed in 84th parts of the circumference, and the Index to the Yoga Table in 86th parts of the same, the Index of the former must be augmented two 84th parts, or one 42d part, in order to adapt it to the latter Table.

14. The four Tables made use of in this method, are next to be considered.

Table XXXVII

The XXXVII th, or Tidhi Table, answers to an Anomalistic revolution of the Moon, and as its Index increases to 84, each unit thereof is nearly one third of a Tidhi, there being 27.9926 Tidhis in an Anomalistic revolution (8). For each Tidhi, therefore, the Index to this Table must be increased 3 0 4. The first column after the Index seems to be that of the Moon's Equation converted into time by the following proportion, viz. as the Moon's true diurnal motion minus the Sun's mean diurnal motion, is to the Moon's Equation expressed in degrees, &c. so is 60g or a natural day to the Equation inserted in the Table. The last column seems to be that of the true diurnal motion of the Moon minus the mean diurnal motion of the Sun expressed in degrees, &c.

Table XXXVIII

The XXXVIII, or Nacshatra Table, answers also to an Anomalistic revolution of the Moon, and as its Index increases to 80, each unit thereof, is nearly one third of the time in which the Moon describes a Nacshatra. Hence, as an Anomalistic revolution or 27^{d} 55 44 (8), is to 80, so is the time of describing a Nacshatra or 1^{d}.01191 (4) to 2.9379 or 2 75 2, the increase of the Index of this Table answering to one mean Nacshatra. The other column seems to be that of the Moon's Equation converted into time by this proportion, viz. as the Moon's true diurnal motion, is to her Equation expressed in degrees, so is 60g, to the Equation inserted in this column.

Table XXXIX

The XXXIX or Yoga Table, answers still to an Anomalistic revolution of the Moon, and as its Index increases to 86, each unit thereof answers to one third nearly of the time of a mean Yoga. Hence 27^{d} 55 46, is to 86, as the time of a Yoga, or .94149 (6), to 2.9385 or 2 75 4, the increase of the Index for one Yoga. The first column after the Index seems to be that of the Moon's Equation converted into time, by the following proportion, viz. as the Moon's true diurnal motion plus the mean diurnal motion of the Sun, is to the Moon's Equation expressed in degrees, &c., so is 60g to the Equation inserted. The last column appears to be that of the true diurnal motion of the Moon plus the mean diurnal motion of the Sun.

Table XI.

The XI. st, or Solar Table, answers to an Anomalistic revolution of the Sun, and as it increases to 371, each unit thereof answers nearly to one Tidhi. The first column after the Index seems to be that of the Sun's Equation expressed in degrees, &c. (in the original it was expressed in seconds), but by the manner in which it is used, the Sun's Anomaly seems to be reckoned from the Perigee and not the Apogee. The last column is that of the semi-diurnal Arcs expressed in time.

For the true time of new Moon.

15. To find the true time of new Moon, or of the beginning of the first Tidhi Padyami.

(15 76 44)
28g 49v
11′ 50

Refer to the Tidhi Table with the Index before found (9), and take out the corresponding numbers, with the proportional parts.

6)23g 49v(3 58
23 48 4
1 4 2

The Lunar Equation being additive, the Index to the Solar Table before found (11) requires an augmentation proportioned thereto. Divide therefore the Lunar Equation by 6, and to the quotient add its 60th part, which gives the correction to be added to the Index to the Solar Table before found.

90 2 59
4 2
90 7 1

(90 7 1)
2° 10′ 23″
14g 44v

With the Index thus corrected, refer to the Solar Table, and take out the corresponding numbers from both columns.

710)7823(11
7810
13
60
)780(1

Divide the Sun's Equation expressed in seconds, by the number taken out of the last column of the Tidhi Table expressed in minutes, (they are so inserted in the original Tables) and the quotient is guddias and viguddias of time. In other words, say, as the Moon's diurnal motion from the Sun, is to 60g, so is the Arc expressed by the Sun's Equation, to the time in which it will be described.

0d 35g 40v
0 23 49
0 11 1
1 10 30
0 14 44
1 21 14

To the mean time of new Moon (3), add the Lunar Equation, and also the Solar Equation reduced to time, and the sum shews the true time of new Moon to fall on the 28th March at 10g.30v after noon, and by adding the semi-diurnal Arc, that it fell on the 28th March at 21g 14v after Sun rise.

For the true time of the end of the 26th Nacshatra.

16. To find the true time of the end of the 26th Nacshatra, or the beginning of the 27th named *Revati*.

(15 46 58)
22g 9v

Refer to the Nacshatra Table with the Index before found (12), and take out the corresponding Equation.

```
0  43  40
0  22   9
---------
1   5  49
0  14  44
---------
1  20  33
```

To the mean time add this Equation, and also the semi-diurnal Arc, which shews that the 27th Nacshatra began on the 28th March at 5^{g} 49^{v} after noon, or at 20^{g} 33^{v} after Sun rise.

For the true time of the end of the 25th Yoga.

17. To find the true time of the end of the 25th Yoga, or beginning of the 26th named *Indra*.

```
17     9   13
20g  47v
13'  55'
```

Refer to the Yoga Table with the Index before found (13), and take out the corresponding number including the proportional parts.

```
  50g  34v  48p
  35   40    2
  -------------
  14   51   46
  20   47    0
  -------------
6)35   41   46(5 57
  35   42    0    5
                ----
                6  2
90   2  59
     6   2
----------
90   9   1
```

The Index to the Solar Table is here not only to be augmented on account of the Lunar Equation, but also on account of the difference between the mean time of new Moon (3) and the mean time of the Yoga, or for 35^{g} 42^{v} in all; and the correction found by article 11 is to be added in the present instance, to the Index to the Solar Table before found.

```
)90   9   1(
2°   10'  25"
```

Refer to the Solar Table with the Index thus corrected, and take out the corresponding Equation.

```
835)7825(9
    7515
    ----
     310
      60
   ---------
   )18600(22
    18370
    -----
      230
```

Divide the Sun's Equation expressed in seconds, by the last number taken out of the Yoga Table expressed in minutes, as in article 15th; or say, as the sum of the diurnal motions of the Sun and Moon, is to 60^{g}, so is the Sun's Equation to the time corresponding.

```
0  50  34
0  20  47
---------
1  11  21
0   9  22
---------
1   1  59
0  14  44
---------
1  16  43
```

To the mean time of the Yoga (7), add the Lunar Equation, and from the sum subtract the time answering to the Solar Equation. Add also the semi-diurnal Arc, and the result shews that the 26th Yoga began on the 28th March at 1^{g} 59^{v} after noon, or at 16^{g} 43^{v} after Sun rise.

For the Carna in the beginning of the year.

18. To find the Carna for the beginning of the year.

```
  30
   2
  --
  60
   1
  --
7)59(8
  56
  --
   3
```

Thirty Tidhis having elapsed since the preceding new Moon, multiply this number by 2, because a Carna is half a Tidhi; and subtract one from the product, because the first Carna begins in the middle of the first Tidhi. As 59 Carnas have passed since the series began, divide this number by 7, and the quotient 8 shews that so many complete series of the seven ordinary Carnas have passed, and the remainder, that three of the four extraordinary Carnas are also past. The last of the eleven Carnas, or the fourth extraordinary Carna begins with the first Tidhi, or at 21^g 14^v after Sun rise on the 28th March, as already found (15).

For the mean time of the beginning of the 2d Tidhi.

19. To find the mean time of the beginning of the 2d Tidhi, 28th Nacshatra and 27th Yoga; or end of the 1st Tidhi, 27th Nacshatra and 26th Yoga.

Tidhi. D.	G.	V.	P.	Nacshatra. D.	G.	V.	P.	Yoga. D.	G.	V.	P.
0	35	40	2	0	43	40	25	0	50	34	48
0	59	3	40	1	0	42	53	0	56	29	22
1	34	43	42	1	44	23	18	1	47	4	10

This is simply to add the mean time of one Tidhi, one Nacshatra and one Yoga (2, 4 and 6) to the mean time of the beginning of the last Tidhi, Nacshatra and Yoga (3, 5 and 7).

For the Indices of the *Tidhi*, *Solar*, *Nacshatra* and *Yoga* Tables.

20. To find the Indices of the Tidhi, Solar, Nacshatra and Yoga Tables, for the time of the beginning of the 2d Tidhi, 28th Nacshatra and 27th Yoga.

Tidhi.			Nacshatra.			Yoga.			Solar.		
15	76	44	15	46	58	17	9	13	90	2	59
3	0	4	2	75	2	2	75	4	1	0	0
18	76	48	18	42	0	20	4	17	91	2	59

To the Indices before found (9, 11, 12 and 13) add the increase of each respectively, for one Tidhi, one Nacshatra, and one Yoga (14).

For the true time of the beginning of the 2d Tidhi.

21. To find the true time of the beginning of the 2d Tidhi.

```
   1°              2°                  4°            5°              6°
                  G.   V.                                          D.   G.   V.
(18 76 48)     6)24  47(4   8     (91  7 11)    725)7827"(10       0   34   43
                 24 .48     4                        7250          0   24   47
                 ------   ----                       ----          0   10   43
  G.   V.                4 12     2° 10' 27"          577          -----------
  24   47                          G.   V.              60         1   10   18
                   3°              14   44          --------       0   14   44
  12°  5'       91   2 59                          )34620(48       -----------
                     4 12                           34800          1   25    2
                ---------                          --------
                91   7 11
```

The 2d Tidhi begins therefore on the 29th March or 1st day of the Tellinga year, at 10^g 18^v after noon or 25^g 2^v after Sun rise.

For the true time when the 28th Nacshatra begins.

22. To find the true time when the 28th Nacshatra begins.

```
    1°            2°
              D.   G.   V.
(18  42  0)   0   44   23
              0   22   59
   G.   V.                    It begins therefore on the 29th March at 7g 22v after noon
   22   59    -----------
              1    7   22     or 22g 6v after Sun rise.
              0   14   44
              -----------
              1   22    6
```

23. To find the true time when the 27th Yoga begins.

For the true time when the 27th Yoga begins.

```
 1o                2o                    3o             5o             D.   G.   V.
                G.  V.  P.                           850)7827"(9        0   47    4
(20  4  17)     47   4  10          91   2  59          7650            0   21   22
                34  43  42                5  42         ----           -------------
G.  V.          ----------          ----------          177             1    8   26
21  22          12  20  28          91   8  41           60             0    9   12
                21  22   0                              ----           -------------
14°  10'        ----------                            )10620(12         0   59   14
              6)33  42  28(5  37         4o            10200            0   14   44
                33  42   0     5    91   8  41          ----           -------------
                ----------  -----                        420            1   13   53
                        28  5  42    2  10  27
```

The 27th Yoga begins therefore, on the 29th March at 13^g 58^v after Sun rise.

24. To find the Carna.

For the Carna.

A Carna being half a Tidhi, the computation of the former differs in nothing from the computation of the latter; only that instead of advancing by a mean Tidhi at a time, as in art. 19, no. 1, we must only advance by half a mean Tidhi at a time.

In the present instance, it need only be observed that the 2d Carna begins with the 2d Tidhi.

25. To find the Wurjum next after the new Moon.

```
      1o
  1d  22g    6v          30g  46v
  0   20    33           20   33
  -------------          --------
  1    1    33           51   19
            30           29   28
  -------------          --------
60)30  46   30(30 46     21   51
   30  46    0
  -------------
```

From the time when the 28th Nacshatra begins (22), subtract the time when the 27th begins (16), and the difference 1^d 1^g 33^v is the time in which the Moon describes the 27th Nacshatra: then say, as 1^d or 60^g, is to the time of the Moon's describing it, so is 30^g the Druva of the 27th Nacshatra to the time of the Moon's describing that Arc, viz. 30^g 46^v.

To the time thus found, add the time of the Moon's entering the 27th Nacshatra; which shews that the Wurjum began 51^g 19 after Sun rise, and subtracting double the semi-diurnal Arc, that it began 21^g 51^v after Sun set.

The Thyajum or continuance of the Wurjum, is reckoned to be 4^g of time.

The Thyajum 4 gudias of time.

PART II.

Method of computing the mean and true places of the Planets in the Zodiac, by means of Astronomical Tables.

1. No Tables are made use of in the Surriah Siddhanta, but modern Astronomers often make use of Tables, and as I have been told that *Vavilala Cuchinna's* Tables agree very well with the Rules given in the Surriah Siddhanta, I shall insert them here, according to the copy which I obtained.

Epoch of Vavilala Cuchinna's Rules and Tables.

It has already been observed, that those who use these Tables commence their computations from noon of the last day of the 4399th year of the Cali yug, for which Epoch, Vavilala has given the Druvas or mean places of the Planets, and their higher Apsides.(*) I have no doubt that he gave the places of the ascending Nodes for the same time, but as I did not obtain this information from my Instructor, I endeavoured to supply it otherwise. Indeed the person from whom I procured a copy, did not know the use of the last column of the Tables for the Annual Equations of the Planets, which I found to be the Chila Carna, and necessary, (according to the method taught in the Surriah Siddhanta,) for finding the Latitudes of the Planets.

2. Druvas or mean places of the Planets, their Apsides, and Nodes, for noon of the last day of the 4399th year of the Cali yug.

Mean place of the Planets on the last day of the 4399th year of the Cali yug, called their *Druva.*

Planets.			Mean place.					Apsis.				Node.			
			s	°	′	″	‴	s	°	′	″	s	°	′	″
Sun	-	-	11	15	26	31	23	2	17	16	19				
Moon (†)	-	-	11	5	48	37	29	4	15	26	17	0	6	12	9
Mars	-	-	9	22	35	27	41	4	10	2	5	1	10	3	42
Mercury	-	-	10	26	48	8	46	7	10	27	18	0	20	42	4
Jupiter	-	-	10	15	45	15	40	5	21	19	48	2	19	40	35
Venus	-	-	8	22	20	19	15	2	19	50	46	1	29	41	56
Saturn	-	-	2	28	53	31	36	7	26	37	27	3	10	22	39

Motion of the Apsides.

The motion of the Apsides of the Planets was stated to me as follows: Sun's Apogee 1′ in 517 years. Mars' Apsis 1′ in 980 years. Mercury's do. 1′ in 544 years. Jupiter's do. 1′ in 222 years. Venus' do. 1′ in 374 years. Saturn's do. 1′ in 5123 years.

(*) Vide Appendix at the end of the Note.

(†) The Moon's Apogee and Node are subject to a Bijah or correction of 4 revolutions in a Maha yug, as was shewn in the Second Memoir, Part II; but the Tellinga Astronomers do not seem to make use of it. This *Bijah*, with its *Druva*, will be found in Table XXII.

Motion of the Nodes.

The motion of the Nodes, according to the rules given in the Surriah Siddhanta, may be stated as follows: Mars' Node 1′ in 935 years. Mercury's do. 1′ in 410 years. Jupiter's do. 1′ in 1149 years. Venus' do. 1′ in 222 years. Saturn's do. 1′ in 302 years. It is to be remembered, that all the Nodes are supposed to have a retrograde motion.

The Ayanansa.

In finding the Ayanansa, or distance between the vernal Equinoctial point and beginning of *Mesha* ♈, at a particular time; it is only to be remembered, that these points are supposed to have been coincident at the expiration of the 3600th year of the Cali yug, and that the Equinoctial points have a retrograde motion at the rate of 54″ in one Sydereal year. To find the Ayanansa, therefore, for the end of the 4899th year of the Cali yug, we have $4899 - 3600 = 1299$, and $1299 \times 54'' = 19^\circ\,29'\,6''$, which is but little different from the Ayanansa for the same period found by the former method.

The Sun, Table XX, mean Elements.

3. A. To find the mean place of the Sun, for the mean time of midnight, at the beginning of the 4900th year of the Cali yug, under the meridian of *Lanca*. From the expired years
4899 of the Cali yug, subtract 4399 years (6 3), and find the number of days contained in the
4399 difference, which is 182618 (*). Then the Sun's mean motion for this number of days,
500 will be found by the Table, as follows:

	s	°	′	″
100000	9	10	15	56
80000	0	8	12	44
2000	5	21	12	19
600	7	21	21	42
10	0	9	51	22
8	0	7	53	5
182618	11	18	47	8

Sun's mean motion from Epoch, Index to Solar Table.

The Sun's mean motion in 182618 days, is therefore found to be $11^s\,18^\circ\,47'\,8''$.

s	°	′	″
11	18	47	8
11	15	26	34
11	4	13	42
0	0	29	34
11	4	43	16

Sun's mean place at Lanca for mean midnight at Lanca.

To the Sun's mean motion for 182618 days, add the Druva (2) and this gives his mean place at noon of the last day of the 4899th year of the Cali yug, to which adding half the Sun's diurnal motion, we get his mean place for midnight, or the beginning of the 4900th year of the Cali yug.

B. To find the place of the Sun's Apogee for the beginning of the 4900th year of the Cali yug.

As the Sun's Apogee moves at the rate of 1′ in 517 years (3), we have $\frac{1' \times 500}{517} = 58''$ for its motion in 500 years.

(*) The manner of finding the Index to Vavilala Cuchinna's Tables was given at Part III, Article 2 of the 2d Memoir. In the present case it will be

I. $\frac{66389 \times 500 + 85211}{180000} = 184$ Adigah months, and $12 \times 500 + 184 = 6184$.

II. $\frac{6270566 \times 6184 - 8875864}{13358334} = 2902$ Cshaya Tidhis, and $30 \times 6184 - 2902 = 182618$ Bhumi savan days, the Index sought.

Place of the Sun's Apogee.

s	°	′	″
2	17	16	19
			58
2	17	17	17

To the Druva or place of the Sun's Apogee at the Epoch, add the motion of his Apogee in 500 years, and this gives the place of his Apogee at the time required.

True or apparent Elements.

C. Given the Sun's mean place 11ˢ 4° 43′, and the place of his Apogee 2ˢ 17° 17′; to find his true place.

Table XXII.

2	17	17
11	4	43
3	12	34

1º With the Argument 3ˢ 12° 34′ refer to the Sun's Anomalistic Table (5) and take out the corresponding Equation + 2 7.

Sun's true place for mean midnight.

s	°	′
11	4	43
	+ 2	7
11	6	50

To the Sun's mean place for the mean time of midnight, apply the Equation with its proper Sign, and it gives his true place for the mean time of midnight.

Sun's true place and true midnight Area Bhagábala.

2º For the Area Bhagábala, take the 365th part of his Equation $+\frac{2^{\circ}\ 7'}{365} = 20''$, which being less than 1′, is here neglected.

Sun's mean diurnal motion 59′ 8″.

D. Given the Sun's mean diurnal motion 59′ 8″; to find his true diurnal motion.

Table XXII.

The Tabular increase of the Sun's Equation for 3° 45′ answering to the Argument 3ˢ 12° 34′ is 1′ 53″, hence $\frac{1'-53\times59'\ 8''}{3^{\circ}\ 45'} = 30''$ is the Equation sought.

59′	8″
	30
59	38

The Sun being nearer his Perigee than his Apogee, the Equation is additive.

The Moon, Table XXI, mean Elements.

4. A. To find the mean place of the Moon, as also of her Apogee and Node, for the beginning of the 4900th year of the Cali yug, and Meridian of Lanca.

First find the motion of each respectively for 182618 days, and then add the Druvas (6 3).

Index.

Days.	Moon.				Apogee (*)				Node.			
100000	1ˢ	5°	12′	53″	11ˢ	8°	17′	27″	8ˢ	18°	28′	52″
80000	0	28	10	18	9	0	37	58	9	8	47	6
2000	2	12	42	15	7	12	45	57	3	15	58	11
600	11	15	48	41	2	6	49	47	1	1	47	27
10	4	11	45	49	0	1	6	50	0	0	31	48
8	3	15	21	39	0	0	58	28	0	0	25	26
182618	11	29	4	35	6	0	31	27	10	15	58	50
Druva - -	11	5	48	37	4	15	26	17	0	6	12	9
Place at Noon -	11	4	53	12	10	15	57	44	1	20	13	19
½ Diurnal motion -		6	35	17			3	20			1	35
Place at midnight -	11	11	28	29	10	16	1	4	1	20	11	44

Moon's mean place.

B. Given the Moon's mean place, and the place of her Apogee; to find her true place.

(*) The Bijah of 4 revolutions in a Maha yug, additive, is here omitted, as already noticed.

11^s	11°	$28'$
		5
11	11	33

1° To the Moon's mean place for the mean time of midnight, add the 27th part of the Sun's Equation $\frac{2^\circ\ 7'}{27} = +\ 5'$, for the Arca Bhagábala; and it gives the Moon's mean place for the apparent time of midnight.

Arca Bhagábala.

10^s	16°	$1'$
11	11	33
11	4	23

2° With the Argument $11^s\ 4^\circ\ 23'$, refer to the Lunar Table, and take out the corresponding Equation $2^\circ\ 11'$.

Table XXIII.

11	11	33
	2	11
11	9	22

From the Moon's mean place corrected, subtract the Equation thus found, and it gives the Moon's true place.

True or apparent Elements.

Moon's true place.

C. Given the Moon's mean diurnal motion $13^\circ\ 10'\ 35''$, and her diurnal motion from her Apogee; to find her true diurnal motion.

The increase of the Moon's Equation for $3^\circ\ 45'$ answering to the Argument $11^s\ 4^\circ\ 28'$, is $18'\ 4''$; and $\frac{13^\circ\ 3'\ 51'' \times 18'\ 4''}{3^\circ\ 45'} = 1^\circ\ 2'\ 56''$, the Equation sought.

Table XXIII.

13°	$10'$	$35''$
1	2	56
12	7	39

This Equation, in the present instance is to be subtracted from the mean motion.

D. To find the Moon's Latitude for the time given.

11^s	9°	$22'$
1	20	12
9	19	10

From the Moon's true place, subtract that of her Node, to get the Argument; the Sine of which is $3247'$, and the Sine of $4^\circ\ 30'$ the inclination of the Moon's Orbit, is $270'$, so that $\frac{270' \times 3247}{3438} = 252'$ is the Sine of the Moon's Latitude and $4^\circ\ 12'$ the Latitude sought, which is South in the present example.

Moon's Latitude.

THE PLANETS.

A. To find the mean place of Mars for the beginning of the 4900th year of the Cali yug.

Mars, Table XLI.

100000	-	6^s	21°	$56'$	$16''$
80000	-	5	11	33	1
2000	-	10	28	2	19
600	-	10	14	24	42
10	-	0	5	14	25
8	-	0	4	11	32
182318	-	9	25	22	15

To Mars' mean motion for 182318 days add the Druva (6 3) $9^s\ 22^\circ\ 35'\ 28''$, and half his mean diurnal motion (6 8) $0^\circ\ 15'\ 43''$, which gives $7^s\ 18^\circ\ 13'\ 26''$ for his mean place at midnight, at the time given.

Ahargana from the Epoch or Index.

Mars' mean place at midnight at Lanca.

B. To find the place of Mars' Apsis and Node for the same time.

Since Mars' Apsis moves at the rate of $1'$ in 980 years (3), we have $\frac{1' \times 500}{980} = 30''$ for its motion in 500 years, and this added to the Druva (6 3), gives $4^s\ 2^\circ\ 10'\ 35''$ for its place at the time given.

His Aphelion.

And since Mars' Node moves at the rate of $1'$ in 935 years (3), we have $\frac{1 \times 500}{935} = 32''$ for

His Node.

its motion in 500 years, which subtracted (because the Nodes move retrograde) from the Druva (3), gives 1s 10° 3′ 10″ for its place at the beginning of the 4900th year of the Cali yug.

For Mars' true place.

C. Given Mars' mean place, the place of his Apsis, and the Sun's mean place; to find the true place.

Arca Bhagábala.

1° To the Sun's mean place apply the 365th part of his Equation before found, and to Mars' mean place apply the 687th part of the Sun's Equation for the Arca Bhagábala; but as these corrections are each of them less than 1′, they are omitted.

♂ place once corrected.

s ° ′
11 4 43
7 18 13
3 16 30

Table XLI, part 3.

7 18 13
+ 18 34

Twice corrected.

8 6 47

2° From the Sun's mean place, subtract that of Mars, both corrected as above, and with this Argument take out the Equation + 37° 8′ from Mars' Annual Table, and apply one half of this to his mean place once corrected, to get it *twice* corrected.

4ˢ 10° 3′
8 6 47
8 3 16

8 6 47
5 10

Thrice corrected.

8 1 37

3° From the place of Mars' Apsis, subtract his place *twice* corrected, and with this Argument take out the Equation 10 20, and apply the half of this to his place twice corrected, to get his mean place *thrice* corrected.

4ˢ 10° 3′
8 1 37
8 8 26

Table XLI, part 2.

♂ true Heliocentric place.

7 18 13
10 45
7 7 28

4° From the place of Mars' Apsis, subtract his place *thrice* corrected, and with this Argument take out the Equation 10° 45′ from the Anomalistic Table, which apply to Mars' place *once* corrected, in order to get his *true Heliocentric* place.

11ˢ 4° 43′
7 7 28
3 27 15

Part 3.

7 7 28
+ 1 9 10

♂ true Geocentric place.

8 16 38

5° From the Sun's mean place corrected by the Arca Bhagábala, subtract Mars' Heliocentric place, and with this Argument take out the Equation + 1ˢ 9° 10′ from the Annual Table, which apply to Mars' Heliocentric place, in order to get his true Geocentric place.

For his true diurnal motion.

D. Given Mars' mean, to find his true diurnal motion.

Table XLI, part 3.

3521′
3438
83

1° From the *Chila carna* answering to the Argument 3ˢ 16° 30′, subtract the *Radius*. From the Sun's mean diurnal motion, subtract that of Mars.

58	8
31	26
27	42

31	26
	20
31	46

Then half the Equation $\frac{27' 40'' \times 83'}{3521} = 39''$ is to be added to, or subtracted from Mars' mean diurnal motion, according as the Chila carna is greater or less than the Radius, in order to get his diurnal motion *once* corrected.

Once corrected.

31'	46"
+1	29
33	15

2° The increase of the Anomalistic Equation for 3° 45′ when the Argument is 8s 3° 16′ is 21′; and half the Equation $\frac{31' 45'' \times 21'}{3 \quad 45} = 2'$ 58" being added to the diurnal motion *once* corrected, gives it *twice* corrected.

Part 2.

Twice corrected.

31'	26"
+2	21
33	47

3° The increase of Mars' Anomalistic Equation for 3° 45′ when the Argument is 8s 8° 26′, is 16; and the Equation $\frac{33' 15'' \times 16'}{3 \quad 45} = 2' \ 21''$ being applied to Mars' mean diurnal motion, gives his diurnal motion *thrice* corrected.

Part 2.

Thrice corrected.

3438'
3124
314

Part 3.

4° Take the difference between the Radius and Chila carna answering to 3s 27° 1U′.

59	8"
33	47
25	21

33	47
2	33
31	14

From the Sun's mean diurnal motion, subtract that of Mars *thrice* corrected.

Then is the Equation $\frac{25 \ 21'' \times 314'}{3124} = 2' \ 33''$ to be applied to Mars' diurnal motion *thrice* corrected, to get his true diurnal motion.

True diurnal motion.

E. To find Mars' Latitude from the foregoing data.

For ♂ Latitude.

1s	10°	3′
1	9	10
2	19	13

To the mean place of Mars' Node (B), add the annual Equation (C, no. 5), which gives its corrected place.

Part 2.
Node corrected.

8s	16°	38′
2	19	13
5	27	25

From Mars' true place (C, no. 5), subtract the corrected place of his Node, and the Sine of the difference is 15 5′, Mars' greatest apparent Latitude being 1° 30′, its Sine is 90′, and the Chila carna is 312 1′ (D, no. 4). Hence $\frac{90 \times 155'}{3124} = 4'$ is the Latitude sought, which in the present example is North.

Table XXX.

♂ true Latitude.

A. To find the mean place of *Mercury* for the beginning of the 4900th year of the Cali yug.

Mercury, Table XLII.

100000	-	9s	1°	48′	16″
80000	-	4	25	26	37
2000	-	8	24	38	10
600	-	9	25	23	27
10	-	1	10	55	23
8	-	1	2	44	19
182618	-	11	0	56	12

To *Mercury's* mean motion for 182618 days, add the Druva (6 3) 10s 26° 48′ 9″ and half his mean diurnal motion 2° 2′ 46″, which gives 9s 29° 47′ 7′ for his mean place at midnight at the time given.

His mean place at midnight at Lanca.

For his Aphelion and Node.

B. To find the place of Mercury's Apsis and Node for the same period.

Since Mercury's Apsis moves 1′ in 514 years, we have (6 3) $\frac{1' \times 500}{514} = 55''$ for its motion in 500 years, and this added to the Druva, gives 7s 10° 28′ 12″ for its place at the given period, and since his Node moves 1′ in 410 years $\frac{1' \times 500}{410} = 1' \ 13''$ is its motion in 500 years; and this subtracted from the Druva, gives 0s 20° 40′ 51″ for its place at the time required.

For ☿'s true place.

C. Given Mercury's mean place, the place of his Apsis, and the Sun's mean place; to find Mercury's true place.

1° Find the Arca Bhagábala for the Sun as before, and to Mercury's mean place add the 88th part of the Sun's Equation $+ \frac{2° \ 7'}{88} = 1'$, which gives 9s 29° 48′ for his mean place *once* corrected.

Sun's mean place once corrected.

	9s	29°	48′
	11	4	43
	10	25	5
XLII, Part 3.	11	4	43
		4	36
Twice corrected.	11	0	7
	7	10	28
	11	0	7
	8	10	21
Part 2.	11	0	7
		2	7
Thrice corrected.	10	28	0
	7	10	28
	10	28	0
	8	12	28
	11	4	43
		4	16
Sun's place four times corrected.	11	0	27
	9	29	48
	11	0	27
	10	29	21
XLII, Part 3.	11	0	27
		8	6
☿'s true Geocentric place.	10	22	21

2° From Mercury's mean place, subtract that of the Sun, both *once* corrected, and with this Argument take out the Equation 9° 11′ from the Annual Table, one half of which applied to the Sun's place *once* corrected, gives it *twice* corrected.

3° From the place of Mercury's Apsis subtract the Sun's place *twice* corrected, and with this Argument take the Equation 4° 14′ from the Anomalistic Table, one half of which applied to the Sun's place *twice* corrected, gives it *thrice* corrected.

4° From the place of Mercury's Apsis, subtract the Sun's place *thrice* corrected, and with this Argument take the Equation 4° 16′ from the Anomalistic Table, and this applied to the Sun's place *once* corrected, gives the *fourth* correction of the Sun's place.

5° From Mercury's place *once* corrected, subtract the Sun's place *four times* corrected, and with this Argument take the Equation 8° 6′ from the Annual Table, and this applied to the Sun's place *four times* corrected, gives Mercury's true Geocentric place.

His diurnal motion.

D. Given Mercury's mean, to find his true diurnal motion.

4533
3438

1095 Radius.

1º From the *Chila carna* answering to the Argument 10ˢ 25° 5′, subtract the Radius.

Part 3.

4 5 32
59 8

3 6 24

From Mercury's mean diurnal motion, subtract that of the Sun.

0 59 8
+ 22 31

1 21 39

Then half the Equation $\frac{3°\ 6'\ 24''\times 1095'}{4533} = 45'\ 2''$ is to be applied to the Sun's mean diurnal motion, in order to get the diurnal motion *once* corrected.

Once corrected.

1° 21′ 39″
+ 1 6

1 22 45

2º The increase of Mercury's Anomalistic Equation, when the Argument is 8ˢ 10° 21′, being 6′, for *one Pinda* or 3° 45′, half the Equation $\frac{1°\ 21'\ 39''\times 6'}{3\ 45} = 2\ 11$ is applied to the mean motion once corrected, to get it twice corrected.

Twice corrected.

0s 59′ 8″
1 50

1 0 58

3º The increase of the Anomalistic Equation for 3° 45′ when the Argument is 8ˢ 12° 23′, being 5′, the Equation $\frac{1°\ 22'\ 45''\times 5}{3\ 45} = 1\ 50$ applied to the Sun's mean diurnal motion, gives it *thrice* corrected.

Part 2.

Thrice corrected.

4572
3438

1134 Radius.

4º From the Chila carna answering to the Argument 10ˢ 29° 22′, subtract the Radius.

Part 3.

4° 5′ 32″
1 0 58

3 4 34

From Mercury's mean diurnal motion, subtract the Sun's *thrice corrected.*

1° 0′ 58″
+ 45 47

1 46 45

Then the Equation $\frac{3°\ 0'\ 34''\times 1134'}{4572} = 45'\ 47''$ applied to the Sun's diurnal motion *three times* corrected, gives Mercury's true diurnal motion.

☿'s true diurnal motion.

E. To find Mercury's Latitude from the same data.

0ˢ 20° 41′
4 16

0 24 57

To the mean place of Mercury's Node, add the Anomalistic Equation (C, no. 4), which gives the Node's place corrected.

For his Latitude.

His Node corrected.

9ˢ 29° 43′
0 24 57

9 4 51

From Mercury's mean Heliocentric place, subtract the corrected place of his Node, and the Sine of the difference is 3425′. Mercury's greatest apparent Latitude being 2°, its Sine is 120′, and the Chila carna 4572 (D, no. 4). Hence $\frac{120'\times 3425'}{4572} = 90'$ gives 1° 30′ for the Latitude sought, which in this example is South.

Table XXX.

XLII, Part 3.

☿'s true Latitude.

NOTE.—The true places of *Jupiter* and *Saturn* are computed in the same manner, *mutatis mutandis*, with that of the Planet *Mars*, and the true place of *Venus* is computed like that of *Mercury*; so that it is needless to add more examples.

The Elements of ♃ and ♄ computed like those of ♂; those of ♀ like ☿'s.

A. To find *Jupiter's* mean place for the beginning of the 4900th year of the Cali yug.

Jupiter, Table XLIII.

100000	0ˢ	29°	38′	3″
80000	5	17	42	27
2000	5	16	11	34
600	1	19	51	28
10	0	0	49	51
8	0	0	39	53
182618	1	24	53	16

To Jupiter's mean motion for 182618 days, add the Druva 10ˢ 15° 45′ 16″, and half the diurnal motion 2′ 20″, which gives 0ˢ 10° 41′ 1″ for his mean place at midnight at the time given.

Index.
♃'s mean Heliocentric place.

His Aphelion.

B. To find the place of Jupiter's Apsis and Node for the same period.

Since Jupiter's Apsis moves 1′ in 222 years, we have $\frac{1 \times 500}{222} = 2' \, 15''$ for its motion in 500 years, and this added to the Druva gives $5^s \, 21° \, 22' \, 8''$ for its place at the given period.

His Node.

And since his Node moves 1′ in 1149 years, $1 \times 500 = 26''$ is its motion in 500 years, which subtracted from the Druva gives $2^s \, 19° \, 40' \, 9''$ for its place at the time required.

Venus, Table XLIV

A. To find the mean place of *Venus* for the beginning of the 4900th year of the Cali yug.

	100000	0	14	38	22
	80000	0	11	42	42
	2000	10	24	17	34
	600	8	1	17	16
Index.	10	0	16	1	17
	8	0	12	49	2
Mean place at midnight at Lanca.	182618	8	20	46	13

To Venus' mean motion for 182618 days, add the Druva (6 3) $8^s \, 22° \, 20' \, 19''$, and half her mean diurnal motion $48' \, 4''$, which gives $5^s \, 18° \, 54' \, 36''$ for her mean place at midnight at the time given.

B. To find the mean place of Venus' Apsis and Node for the same period.

Her Aphelion.

Since Venus' Apsis moves 1′ in 374 years, we have $\frac{1 \times 500}{374} = 1' \, 20'$ for its motion in 500 years, and this added to the Druva gives $2^s \, 19° \, 52' \, 6''$ for its place at the given period.

Her Node.

And since her Node moves 1′ in 222 years, $\frac{1 \times 500}{222} = 2' \, 15''$ is its motion in 500 years, and this subtracted from the Druva gives $1^s \, 29° \, 39' \, 41''$ for its place at the time required.

Saturn, Table XLV

A. To find *Saturn's* mean place for the beginning of the 4900th year of the Cali yug.

	100000	3	13	55	51
	80000	5	5	8	40
	2000	2	6	52	13
	600	0	20	3	49
Index.	10	0	0	20	4
His mean place at midnight at Lanca.	8	0	0	16	3
	182618	11	16	37	10

To Saturn's mean motion for 182618 days, add the Druva $2^s \, 23° \, 53' \, 32''$, and half his diurnal motion $1' \, 0'$, which gives $2^s \, 15° \, 31' \, 42''$ for his mean place at midnight at the time given.

B. To find the place of Saturn's Apsis and Node for the same period.

His Aphelion.

Since Saturn's Apsis moves 1′ in 5128 years, we have $\frac{1 \times 500}{5128} = 5''$ for its motion in 500 years, and this added to the Druva gives $7^s \, 26° \, 37' \, 32''$ for its place at the time required.

His Node.

And since his Node moves 1′ in 302 years, $\frac{1' \times 500}{302} = 1' \, 39''$ is its motion in 500 years, which subtracted from the Druva gives $3^s \, 10° \, 22' \, 0''$ for its place at the time required.

Arca Bhagábalas of the respective Planets.

In using this method, the Arca Bhagábala for *Jupiter* is supposed to be the 4334th part of the *Sun's* Equation; that for *Venus* the 598th part, and that for *Saturn* the 10800th part of the *Sun's* Equation.

These contractions are easily deduced from what was explained in the former section, it being only necessary to divide 360° by the mean diurnal motion of the Planet.

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PART III.

METHOD of computing the Declination, Ascension, Amplitude, &c. of the Planets, &c. &c. a Fragment.

The Moon.

A. GIVEN the *Moon's* true place in the Zodiac, her Latitude, and the Ayanansa, to find her Declination.

$$\begin{array}{rrr} 11^s & 9^\circ & 22' \\ & 19 & 29 \\ \hline 11 & 28 & 51 \end{array}$$

1° To the *Moon's* true place, add the Ayanansa, which gives the Moon's Longitude, the Sine of which is 69′ and $\frac{69 \times 1397'}{3438} = 28$, answers to the Declination of a point of the Ecliptic which has the same Longitude that the Moon has in her own Orbit.

$$\begin{array}{rr} 4^\circ & 12' \\ & 28 \\ \hline 4 & 40 \end{array}$$

2° Because the *Moon's* Latitude and the Declination just found are both South, their sum is supposed to give the Moon's true South Declination.

Mars.

B. Given *Mars'* true place, the Ayanansa, and his Latitude, to find his Declination.

$$\begin{array}{rrr} 8^s & 16^\circ & 33' \\ & 19 & 29 \\ \hline 9 & 6 & 7 \end{array}$$

1° To *Mars'* true place, add the Ayanansa, which gives his Longitude, the Sine of which is 3416′ and $\frac{3416 \times 1397}{3438} = 1389'$, which answers to 23° 51′ the Declination of that point of the Ecliptic which has the same Longitude that Mars has in his Orbit.

$$\begin{array}{rr} 23^\circ & 51' \\ & 4 \\ \hline 23 & 47 \end{array}$$

2° From the Declination thus found, which is South, subtract Mars' Latitude, which is North, and the difference is the Declination sought.

Mercury.

Given Mercury's true place, the Ayanansa, and his Latitude, to find his Declination.

$$\begin{array}{rrr} 10^s & 22^\circ & 21' \\ & 19 & 29 \\ \hline 11 & 11 & 50 \end{array}$$

1° To Mercury's true place, add the Ayanansa for the Longitude, the Sine of which is 1072′; and $\frac{1072' \times 1397}{3438} = 436'$, which answers to 7° 17′ the Declination of the corresponding point of the Ecliptic.

$$\begin{array}{rr} 7^\circ & 17' \\ 1 & 30 \\ \hline 8 & 47 \end{array}$$

2° As the Declination of this point and Mercury's Latitude are both South, their sum is to be taken as Mercury's true Declination.

NOTE.—Although this method of finding the Declination of the Planets be not perfectly correct, yet the principles on which it is founded, are exceedingly obvious.

The Moon's Ascensional difference.

The Moon's Declination being supposed 4° 40′ South, to find the Ascensional difference.

For the Cshetijya $\frac{962 \times 280}{3299} = 82'$, and for the Charajya $\frac{82' \times 3438'}{3426} = 82$, which is the Ascensional difference sought.

In both this and the last example the second operation might have been omitted, but that is only the case when the Declination happens to be small.

As the reader may be desirous to see how the mean Elements of the Planets are resolved by the Rules of the Suriiah Siddhanta, I shall close this paper with summary examples for each. The manner of deducing their apparent places, therefrom, are the same as those indicated by Varilala Cuchinna.

General Problem.

For the mean places of the Planets.

To find the mean distance of each Planet from the beginning of the Zodiac for the commencement of any year, which let it be that of the 4900th year of the Cali yug (falling on the 19th March 1798) at midnight, under the Meridian of Lanca.

Rule.

The Rule may be expressed as follows:

As the number of Bhumi-savan or natural days in a Maha yug;

Is to the number of Bhaganas, or mean Sydereal revolutions of the Planet, in the same time;

So is the Strostidi Digona;

To the number of Revolutions and parts of a Revolution of the Planet in the same time.

N. B.—The complete Revolutions are seldom wanted; but the excess above complete Revolutions, gives the mean place of the Planet from the beginning of the Zodiac.

1º The Strostidi Digona being computed for the end of the Luni-solar year 4899 of the Cali yug, as indicated in the second part of the Key to the *Siddhanta Chandra Mana*, will be found to be 714404036004 Bhumi-savan days, of which there are 1577917828 in a Maha yug.

		Revolutions. B. Savan days.	Complete Revolutions.	Parts.			
☉.	1º For the Sun's mean place	$\frac{4320000 \times 714404086004}{1577917828} =$	(1955384398)	11ˢ	4°	43′	16″
☽.	2º For the Moon's mean place	$\frac{57753336 \times 714404086004}{1577917828} =$	(26147838366)	11	11	28	29
♂.	3º For Mars' mean place	$\frac{2296832 \times 714404086004}{1577917825} =$	(1039893292)	7	18	13	26
☿.	4º For Mercury's mean place	$\frac{17937060 \times 714404086004}{1577917828} =$	(8121024255)	9	29	47	7
♃.	5º For Jupiter's mean place	$\frac{364220 \times 714404086004}{1577917828} =$	(164901018)	0	10	41	1
♀.	6º For Venus' mean place	$\frac{7022376 \times 714404086004}{1577917828} =$	(3179388697)	5	13	54	36
♄.	7º For Saturn's mean place	$\frac{146565 \times 714404086004}{1577917828} =$	(66358823)	2	15	31	42

For the mean distances of the higher Apsides from the beginning of the Hindu Zodiac.

For the higher Apsides of the Planets.

To find the mean distances of the higher Apsides and ascending Nodes of the Planets from the beginning of the Zodiac, for the commencement of the 4900th year of the Cali yug, the rule differs in nothing from that in the last article; only that instead of a *Maha yug*, a Calpa (or 1000 Maha yugs) is made use of for this purpose; excepting for the Moon.

Revolutions. Bhumi Savan days. Apogee.

1° For the Sun's Apogee - - - $\frac{387 \times 714404086004}{1577917828000} =$ (175) $2^s\ 17^\circ\ 17'\ 16''$ ☉ A

2° For the Moon's Apogee A Maha yug $\frac{488203 \times 714404086004}{1577917828} =$ (221034461) 10 16 1 4 ☽ A

For the Bijah or correction (*) - - $\frac{4 \times 714404086004}{1577917828}$ + 0 1 33 1

Moon's Apogee 10 17 39 5

3° For Mars' Aphelion - - A Calpa $\frac{204 \times 714404086004}{1577917828000} =$ (92) 4 10 2 35 Aphelion. ♂ A

4° For Mercury's Aphelion - - - $\frac{388 \times 714404086004}{1577917828000} =$ (166) 7 10 28 12 ☿ A

5° For Jupiter's Aphelion - - - $\frac{900 \times 714404086004}{1577917828000} =$ (407) 5 21 22 3 ♃ A

6° For Venus' Aphelion - - - - $\frac{535 \times 714404086004}{1577917828000} =$ (212) 2 10 52 6 ♀ A

7° For Saturn's Aphelion - - - - $\frac{39 \times 714404086004}{1577917828000} =$ (17) 7 26 37 52 ♄ A

For the place of the Nodes.

The rule is the same as for the upper Apsis of the Planets, with this only difference, that they are all supposed to move in *Antecedentia* or retrograde. For the Nodes of the Planets.

Revolutions. Bhumi Savan days.

1° For the Moon's Node $\frac{232238 \times 714404086004}{\text{A Maha yug } 1577917828} =$ (105146017) $10^s\ 9^\circ\ 48'\ 16''$ ☊. ☽.

The Bijah the same as for the Apogee + 0 1 33 1

Place of ☽'s Node - - - 10 11 26 17 and its supplement to 12^s is $1^s\ 18^\circ\ 33'\ 43''$.

2° For Mars' Node - A Calpa $\frac{214 \times 714404086004}{1577917828000} =$ (96) $10^s\ 19^\circ\ 56'\ 50''$ and its supplement to 12^s is $1^s\ 10^\circ\ 3'\ 10''$. ☊. ♂.

3° For Mercury's Node - $\frac{488 \times 714404086004}{1577917828000} =$ (220) 11 9 19 9 and its supplement to 12^s is $0^s\ 20^\circ\ 40'\ 51''$. ☊. ☿.

4° For Jupiter's Node - $\frac{174 \times 714404086004}{1577917828000} =$ (78) 9 10 19 51 and its supplement to 12^s is $2^s\ 19^\circ\ 40'\ 9''$. ☊. ♃.

5° For Venus' Node - $\frac{903 \times 714404086004}{1577917828000} =$ (408) 10 0 20 19 and its supplement to 12^s is $1^s\ 29^\circ\ 39'\ 41''$. ☊. ♀.

6° For Saturn's Node - $\frac{662 \times 714404086004}{1577917828000} =$ (299) 8 19 29 0 and its supplement to 12^s is $3^s\ 10^\circ\ 31'\ 0''$. ☊. ♄.

N. B.—The places of the Planets may be resolved from the beginning of the Cali yug by

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(*) The Bijah is prescribed by the *Tika*, but not by the *Surriah Siddhanta*.

means of Table XX, XXI, XLI, XLII, XLIII, XLIV, and XLV, when the Ahargana is known. But for the Aphelions and Nodes, if these Tables be used, the Epochs and *Druvas* given at the foot of the Tables must be referred to, and the Index must be computed as shewn at Part III, Article 2, of the Key to the *Siddhanta Chandra Mana.*

END OF THE APPENDIX TO THE SECOND MEMOIR.

THIRD MEMOIR.

ON THE

INDIAN CYCLE OF 60 YEARS

OR

VRIHASPATI CHACRA;

OR

CIRCLE OF JUPITER.

ADVERTISEMENT.

The Indian Cycle of 60 years, or *Vrihaspati Chacra*, in any one of its forms, is of little, or no use in the resolution of Astronomical Problems. The Tellinga Astronomers alone, apply theirs to the computation of the years elapsed of the Cali yug, for finding the Ahargana and *Soota dina*, or day of the full or new Moon.

But in a Chronological point of view Jupiter's Cycle is important, because it was ever a practice in Southern India, when dating documents, to annex the name of the year of the Chacra to that of the concurrent Solar and *Luni-solar* years; and as we know of three different styles bearing the same denomination, two of which occasionally expunge one Chacra year out of the Kalendar, whereas the third (also under the name of *Vrikaspati*) records merely *common Solar years, without any omission*, it follows that in verifying dates, great mistakes may be made, if attending merely to the name or numeral of the Chacra year. It will be seen in the following pages, that in present times the expunged years of the *Jyautistava* Style, precedes those of the Surriah Siddhanta by 13 *years;* and that the whole of the Chacra or Cycle, according to the Tellinga Astronomers, whilst in reality it was 56 years in A. D. 1800 behind those of the two former authorities, yet from their manner of telling off the odd years of the Cycle, it seems to lose only 11 years in the said Christian year.

A view of the Epochs of expunged years from the beginning of the Cali yug to A° 5128 complete (A. D. 2026) according to the Surriah Siddhanta, is given in a separate Table (XVIII, page 20), and in another (XIX, page 23) the same, according to the Jyautistava, from the birth of Salivahana (A. C. 3179, A. D. 78) down to the 2033d Christian year. It also exhibits the difference of Epochs of the two Styles.

These Tables will suffice to rectify by *inspection*, any date recorded in Vrikaspati years *only* (which sometimes happens on old inscriptions, when that of the other Styles is obliterated by time), provided it be known to which Style it belongs; a circumstance which must depend on the country which gave birth to the document.

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On the Indian Cycle *of* 60 Years or Vrihaspati Chacra. (*)

I have not been able to discover the origin of the practice of reckoning time with reference to the revolutions of the Planet Jupiter, but it is no doubt very ancient; not only from there being nothing on record, but from the circumstance of its legitimate application having (if it ever did) long since fallen into disuse in the Peninsula of India, where 60 Solar years are supposed to be equal to five revolutions of the Planet, a proposition which is warranted neither by the Surriah Siddhanta, the Tikas, nor observation.—Generally, one year of Jupiter's Cycle is supposed to answer to the time during which the Planet passes through one Sign of the Zodiac.

Solar year of the Surriah Siddhanta 365d 15g 31v 31p 24s

♃'s motion uncorrected 1s. 0° 21′ 6″

Bijah 2‴ 24⁗ per annum.

The mean Solar Sydereal year, according to the Surriah Siddhanta, consists of $365^d\ 15^g\ 31^v\ 31^p\ 24^s$ (neglecting 24 suras). Of Jupiter's revolutions there are 364220 in a Maha yug; therefore Jupiter's motion in a Solar year is $\frac{364220}{4320000}$ = $1^s\ 0^{\circ}\ 21'\ 6''$ exactly. Subsequent Astronomers however, finding that this quantity deviated from the observation, have imagined a correction of 8 revolutions of the Planet in a Maha yug; whence we have, as 4320000 to 8 revolutions, so one Solar year of $365^D\ 15^g\ 31^v\ 31^p$ to $2'''\ 24''''$ the correction or Bijah, which is subtractive;

Therefore - - - - -	1^s	0°	$21'$	$6''$	$0'''$
Bijah - - - - - - -			—	2	24
Corrected motion in 1 Solar year - - -	1	0	21	3	36

Motion in 1 Solar year 1s. 0° 21′ 3″ 36‴

♃'s year 361D 2g 4p 41c,2329 in Solar time.

In order to have Jupiter's year expressed in Solar time we have, as $30^{\circ}\ 21'\ 3''\ 36'''$ to $365^D\ 15^g\ 31^v\ 31^p$, so 30° to $361^D\ 2^g\ 4^v\ 41^p$,2329 &c. the true duration of the Chacra year.

Such are the quantities which govern the Tables at the end, constructed for the purpose of abridging these long and tedious operations.

Three Rules or Systems for the Cycle of 60 years.

There are several Rules for computing the years of the Chacra, three of which I shall consider as being the most in use, viz. 1º That of the *Surriah Siddhanta;* 2º that of the *Jyautistava;* and 3º that of the *Tellingas*, the latter of which is followed in the Southern parts of India.

Mr. Davis has explained in a general manner the theory of the two former, in a Memoir published in the IIId volume of the Asiatic Researches, but as it required much extension to reduce the respective problems to practice, I shall enter more minutely into the subject than he did.

(*) This Cycle has been imagined, but without foundation, to be the same as the Chaldean Saros.

According to the Surriah Siddhanta.

Precept by the Surriah Siddhanta.

"Multiply by 12 Jupiter's expired bhaganas (revolutions) and (to the product) add the Sign "he is in; divide (the sum) by 60, the remainder or fraction shews his *current* year, counting "from Vijaya" (the 27th of the Chacra inclusive) "as the first of the series." (Asiat. Researches, volume III, page 213).

How to find Jupiter's elapsed revolutions and mean Heliocentric Longitude at any given Epoch, will be shewn in another part of this collection. At present let it be understood, that it may be readily obtained by means of Table XI. As for the Bijah, Mr. Davis has shewn that 4320000 years are to 8 revolutions, as 1500 years, to 1. Hence 1500 : 1 :: x : $\frac{x}{1500}$, which is the general expression of the Bijah, x representing the years expired since the commencement of the Cali yug, when the Planets were supposed to be in conjunction in the first point of the Hindu Zodiac.

EXAMPLE I.

Example by the Rule.

Let it be proposed to find the rank, name and beginning of the *Vrihaspati* year concurring with A. C. 4871, relatively to the commencement of the said Solar Sydereal year *current*, or 4870 *complete*.

Say, as 4320000 Solar years, to 364220 revolutions of Jupiter, so 4870ʸ to 410ʳ 7ˢ 2° 37′ 0″, the revolutions and Longitude of ♃, at the end of the said year.

For the Bijah we have $\frac{4870}{1500}$ =	—	0ˢ	3°	14′	18″
Longitude uncorrected		7	2	37	0
♃'s mean Heliocentric Longitude corrected		6	29	22	12

For the number of Cycles expired and years current.

$$\begin{array}{rr} \text{Rev.} & 410 \\ \times & 12 \\ \hline & 4920 \\ + & 7 \\ \hline 60) & 4927(82\ \text{Cycles.} \\ & 127 \end{array}$$

Remainder 7 years, from Vijaya, the 27th year of the Chacra inclusive, which therefore makes *Vicari* the 33d, the year current. But here it is to be remembered, that the numeral 33 is merely *nominal*, as will be shewn hereafter.

For the time of beginning of the said year Vicari, relatively to that of the concurrent Solar year 4871, say, as 2° 30′ to 1 month *of 30 days of Jupiter's own time*, so 29° 22′ 12″ (the remaining part of the Longitude) to 11 months, 22 days (352ᵈ), 26 dandas, 23 palas, 19,80 *castacalás* of *Saura* time, which shews the portion of the Planet's time in the year Vicari *expired* on the 1st Chaitram (Bengal Vaisácha) A. C. 4871 current.

Now to have the precise date in *Solar time*, say as before (page 199), as 30° 21′ 3″ 36‴ to 365D 15d 31p 31c, so 29° 22′ 12″ to 353D 27d 10p 31c (*), the number of Solar days, dandas, &c. elapsed of *Vicari* on the 1st Chaitram 4871 of the Cali yug.

Date of the beginning of the Vrihaspati year according to the European Kalendar.

For the date of the beginning of the said Vrihaspati year according to the Christian Kalendar, finding by the General Solar Table at the end of the volume, that the year Cali yugam 4870 *ended* on the 9th April 1769 N. S. it follows that the commencement of the year *Vicari* fell on the 21st April 1768.

According to the Hindu Solar Kalendar.

And if the Civil date according to the Hindu Solar Style be required, the process indicated in the preceding Memoir, is to be followed.

How to compute the same by the Tables.

The same by the Tables.

Let Jupiter's mean Heliocentric Longitude for the end of the same year Cali yugam 4870, be required. Then by Table XI, we have

		R	S	°	′	″
Epoch 4400	Druva - -	370	11	17	20	0
4870	Column III, 400 -	33	8	20	40	0
470	II, 70 -	5	10	24	37	0
		410	7	2	37	0
	Bijah -	-	—	3	14	48
For the Bijah, Table XII, page 15.		410	6	29	22	12

Epoch 4400				
Druva - -	2°	56′	0″	
Column III, 400		16	0	
Column II, 70		2	48	for 6°
Bijah - -	3	14	48	

410
12
4920
+ 7
Cycle. y.
60)4927(82 7 from Vijaya the 27th.
127

Therefore Vicari the year current - - 7

	°	′	″	
For the Solar time due to	29	22	12	By Table XIII, page 16.
Column I, 20° -	210	41	23	9,4886
9 -	108	18	37	25,2699
II, 20′ -	4	0	41	23,1581
2 -		24	4	8,3159
III, 10″ -		2	0	20,6929
2 -			24	4,1386
Solar time expired of *Vicari* -	353D	27d	10p	31c,0640

The same (neglecting the decimals) as in the preceding Rule.

N. B.—The Table XLIII (page 56 of the Tables) of Vavilala Cochinna, give ♃'s motion in 30 days 2° 29′ 34″ 24‴, which for one Solar year amount to 1s 0° 21′ 3″ 26‴, differing only from the

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(*) For ♃'s year expressed in Solar time, say:

As 30° 21′ 3″ 36‴ : 365D 15d 31p 31c :: 30° : 361D 2d 4p 41c,23293
6553816‴ 75895891c 6480000‴ 77983184,23293

The length of Jupiter's year, which governs Table XIII, page 16.

quantity given by the Surriah Siddhanta, (corrected by the Bijah) by 10ᵛ, answering to 2 pal. 0,3448 cast. in Solar time.

'RULE.

The same according to the Jyautistava (a book on Astrology.)

This Rule expounds the *last expired*, instead of the current year of the Chacra.

Jyautistava Rule.

Precept.

" The Saca years note down in two places. Multiply (one of the numbers) by 22. Add (to the " product) 4291. Divide (the sum) by 1875. The quotient (its integers) add to the 2d number " noted down, and divide (the sum) by 60. The remainder or fraction will shew the last year " expired, counting from Prabhava (inclusive) as the first of the Cycle. The fraction, if any left " by the divisor 1875, may be reduced to months, days, &c. expired of the current year." (Asiat. Res. vol. III, p. 214).

1st result in *Saura* time.

The Jyautistava uses the Solar year according to the Aria Siddhanta 365d 15 31 15.

Here it is proper to observe, that the fraction of the first term when amounting to unit represents one Chacra year of 360 days, which the Hindus call *Saura* time; therefore, in order to have the true *Solar time* elapsed it will be, as 360ᵈ Saura to 365ᵈ 15ᵍ 31ᵛ 15ᵖ (the duration of the Solar year according to the Aria Siddhanta), so is the number of Saura days elicited by the fraction reduced into time, to the corresponding number of days, &c. in Solar Sydereal time.

EXAMPLE II.

Example by the Rule.

Let the year of the Cali yug 4870, or (4870—3179, 1691 Saca complete, be proposed: wanted the circumstances of the concurrent Vrihaspati year.

By the foregoing precept we have 1691.

$$\frac{1691 \times 22 + 4291}{1875} = 22\ \frac{873}{1875} \text{ and } \frac{1691 + 22}{60} = 28\ \frac{33}{60}$$

The first fraction when reduced into time ($\frac{873}{1875}$), shews that 5ᵐ 17ᵈ 36dan 57p,6 had *expired* of the year indicated by the 2d fraction ($\frac{33}{60}$), i. e. *Vicari*, on the 1st Chaitram of the year 1692 Saca current, in *Saura time;* to reduce which into *Solar time* we have, as 360ᴰ : 365ᴰ 15ᵈ 31p,25 :: 5ᵐ 17ᵈ (167ᵈ) 36dan. 57p,6 : 170ᴰ 3ᵈ. 51p,91 or 170ᴰ 3ᵈ 51p.51,7cast. And as the Solar year began on the 9th April A. D. 1769 (*), it follows that (according to this Rule) the Chacra year *Sarvari* (the 34th and current one) began on the 21st October A. D. 1768.

In comparing hereafter the results of the two foregoing Rules, we shall thus find them expressed in the same species of time, which Mr. Davis has omitted to consider.

How to compute the same by the Tables.

The fraction of the first member of the expression will be expounded as follows, by Table XIV, page 16.

The same by the Tables,

		Numerator.		D.	dan.	p.
	Column III, for	800	-	153	36	0
	II,	70	-	13	26	24
	I,	3	-		34	33,6
5ᵐ 17ᵈ 36dan. 57p,6		in Saura time		167	36	57,6

(*) Solar General Table at the end.

To reduce which to Solar time, by Table XVI, page 13.

			D.	dan.	p.		D.	dan.	p.	cast.
Column I,	100	-	101	27	38,68200					
II,	60	-	60	52	35.20920					
	7	-	7	6	8.10774					
	30	-		30	26,29341					
	6	-		6	5,25868					
III,	50	-			50,73037					
	7	-			7,10224					
	0,6	-			0,60876					
Expired in Solar time		-	170	3	51,91240	or	170	3	61	54,744

The same result as by the Rule.

ILLUSTRATION.

Illustration.

The multiplier 22, and the divisor 1875, are explained in the following manner by Mr. Davis.

According to the Aria Siddhanta 364224 rev. of ♃ in a Maha yug.

According to the Astronomical treatise called the Aria Siddhanta, there are 364224 mean revolutions of Jupiter in a Maha yug (instead of 364220 assigned by the Surriah Siddhanta, the Solar years of the latter being $365^D\ 15^d\ 31^p\ 31^c$ and of the former $365^D\ 15^d\ 31^p\ 15^s$); therefore 364224 rev. contain 4370688 of the Planet's *own years*, which exceed the Solar years in a Maha yug by 50688", and 4320000' and 50688 being reduced to their lowest terms are 1875 and 22; therefore in 1875 Solar years, there is an excess of 22 Vrihaspati years.

Cshepa, an Equation which adapts a computation to a particular period.

The additive number (1st member) 4291, by the Hindu Astronomers called *Cshepa*, adjusts the computation to the commencement of the Æra Saca, or the birth of Salivahana, which occurred when 3179 years of the Cali yug had expired. In order, therefore, to have the time elapsed of the Vrihaspati account at that Epoch, if we use the above formula it will be $\frac{0 \times 22 + 4291}{1875} = 2\frac{541}{1875}$ and $\frac{0+2}{60} = 0\frac{2}{60} = \frac{4291}{1875} = 2^y\ 3^m\ 13^d\ 52^{dan.}\ 19^p{,}2$ in *Saura* time, and $2^y\ 105^d\ 23^{dan.}\ 21^p\ 29^c{,}8872$ (Table XVI) *of mean Solar Sydereal time*, which had already expired of the 54th Cycle when that Æra began. (*)

Epoch of Vrihaspati reduced to the Æra of Salivahana.

(*) In order to compare this Epoch as expounded by the two Rules, we shall compute the same by that of the Surriah Siddhanta, as follows:

Epoch 4400
3179
1221

	years.		R.	s.	°	'	"	
Table XI, Column III,	1000	-	84	3	21	40	0	
	200	-	16	10	10	20	0	
II,	20	-	1	18	7	2	0	
I,	1	-	0	1	0	21	6	
	1221	—	102	11	9	23	6	
Druva - -			370	11	17	20	0	
			268	0	7	56	54	
Bijah - - - -					2	7	9	36
			268	0	5	49	44	24

12
536
2680
1
60)3217(53 $\frac{37}{60}$ c.
217
Remainder 37

For the Bijah.
Table XII.

			'	'	"
Column III,	1000	-	40	0	0
	200	-	8	0	0
II, -	20	-		48	0
I, -	1	-		2	24
	1221	—	48	50	24
Druva -	2	-	56	0	0
Bijah -	2	-	7	9	36

RULE.

According to the Tellinga Astronomers.

Rule according to the Tellingas.

This Rule gives the last expired year from the beginning of the Cali yug: it takes no notice of the commencement of the Vrihaspati year, which it identifies with that of the *Chandra mana*, or Luni-solar year current.

Precept.

" Divide the expired years of the Cali yug by 60, the quotient will give the number of Cycles " expired, and the first year of the remainder will answer to *Pramathi* the 13th year of the " Chacra. Count the number of units of the said remainder from the said Pramathi (inclusive). " you have the year of the Chacra last expired, and that which follows is the current one."

EXAMPLE.

Rule.

Let it be proposed to find the rank and name of the Vrihaspati year concurrent with A. C. 4870 complete, or 4871 current.

By the above precept we have

$$60)4870(81\tfrac{10}{60}$$
$$70$$
$$10$$

and the numerator of the fraction 10 being told off from Pramathi *inclusive*, gives *Sarvadhari* the 22d, as the last expired, and *Virodhi* the 23d, as the current year sought; the integers shewing that 81 Cycles have elapsed since the beginning of the Cali yug, and therefore that the 82d is the current one.

Comparison of the three results.

Comparison of the three results.

In order to compare the number of Cycles and years expired according to each Rule, we are not to refer to the *numerals* of the *Chacra* years, as arranged in the series given in modern Astronomical books; because each authority begins from a different point of the Chacra for counting the odd years after division by 60; without any reference to the revolutions of the Planet at any given Epoch, which nevertheless are the true scale by which such time should be measured.

---

which remainder 37, counted from Vijaya the 27th of the Chacra, falls on *Suda* the 3d year *current* of the 54th Cycle complete; and for the time due to 5° 49′ 44″ 24‴ Longitude of the Planet on the 1st day of the Solar year Cali yugam 3180, we have

				D.	d.	p.	e.
Table XIII, Column I,	5°			60	10	40	47,3722
II,	40′			8	1	22	46,3164
	9			1	48	18	37,4212
III,	40″			-	8	1	22,1719
	4			-		48	8,2772
IV,	20‴			-		4	0,6897
	4			-		-	48,1390
Solar time expired at the beginning of the Æra Saca		Cycles. 54	2 years	70	8	56	20,9265
			2	105	23	21	29,8672
			Difference	35	14	24	58,9007

By the Surriah Siddhanta.

The Surriah Siddhanta, from counting the odd years from Vijaya (the 27th) as *one* or Nandana (26th) as zero, considers manifestly that Jupiter and the Sun were once in the first point of Mesha at the beginning of *Vijaya* and of the Cali yug. Thus in Example I, page 200, we found that at the end of the Solar year of the Cali yug 4870, the current Chacra year was *Vicari* (33d) and the last expired *Vilamva* (32d) of the 83d Cycle current. But the revolutions and Longitude of Jupiter at that instant were $410^r\ 6^s\ 29^\circ\ 22'\ 12''$, which gave $82^c\ 6^y$ *complete*, the 6 years to be counted from *Nandana* as zero, and therefore *Vilamva* the 6th in the series marks the true time elapsed, and not *Vilamva* the 32d, as numbered in the modern list. The former is consequently that to be used for comparison.

By the Jyautistava.

2º The *Jyautistava* rule which computes in Solar years, but with reference to Jupiter's motion, takes the series to be numbered as in the list referred to, viz. *Cshaya* the 60th year of the Chacra as *zero* and *Prabhava* as *one*. But in so doing it uses a *Cshepa* of 27 years earlier than the Surriah Siddhanta, which adapts the numerator of the fraction of the second member of its rule, to the year elicited by the latter.

Thus in Example 2, page 202, the cycles and years expired in the year Cali yug 4870 complete from the birth of Salivahana are, 28 cycles, 33 years, to which adding 54 years, we have for the cycles and years expired since the beginning of the Cali yug $82^c\ 33^y$, if from this we subtract 27

$$\begin{array}{rr} & -\ 27 \\ \hline \text{we have } 82 & 6 \end{array}$$

, the same numbers as those elicited by the rule of the Surriah Siddhanta when taking Vijaya as 1 of the series.

According to the Tellingas.

3º With respect to the Tellingas, as their account is entirely *Solar* without any reference to the motion of Jupiter, the difference is exactly that arising out of the *Solar* and *Vrihaspati* years expired. Hence if we divide the year of the Cali yug 4870 by 60,

$$\begin{array}{lrr} \text{we have for quotient} & 81^c & 10^y \\ \text{which subtracted from} & 82 & 6 \\ \hline \text{leaves} & 0 & 56 \end{array}$$

which 56 years mark the number of expunged or *Cshaya* years which have occurred since the beginning of the Cali yug, as will be shewn from other principles.

From the foregoing considerations it follows, that the relative measure of time of the respective accounts is not to be deduced from the numerals of the years of the Chacra according to our list, but from the actual revolutions of the Planet as expounded at page 200, Example I, the former giving the following *erroneous* results, viz.

$$\begin{array}{lrr} \text{From the Surriah Siddhanta} & 82^c & 32^y \\ \text{Jyautistava} & 82 & 33 \\ \text{Tellinga} & 81 & 22 \end{array} \begin{array}{l} \left.\vphantom{\begin{array}{l}a\\a\end{array}}\right\}+\ 0^c\ \ 1^y \\ \left.\vphantom{\begin{array}{l}a\\a\end{array}}\right\}-\ 1\ \ 10 \text{ or 70 years, which on} \end{array}$$

a first view might be supposed to be the correct ones.

Of the Cshaya or expunged year.

Of the expunged year according to the Surriah Siddhanta, with the correction of the Tika.

I shall now proceed to explain the occasion of the Cshaya, or expunged year of Jupiter due at certain periods, resulting from the theories of the Surriah Siddhanta and Jyautistava, that omission being unknown to the Tellingas.

Surriah Siddhanta.

We have seen at page 199, that the mean motion of Jupiter in Heliocentric Longitude according to the Surriah Siddhanta (corrected as the Tika directs), in a Solar year of

$365^D\ 15^d\ 31^p\ 31^c$, is - - - - =		1ˢ	0°	21′	3″	36‴
Multiply by - -						× 85
Mean motion during 85 Solar years -	7ʳ	1	29	50	6	0
Add motion for 1 year - -		1	0	21	3	36
Mean motion during 86 Solar years - -	7	3	0	11	9	36

Here it will be perceived that during the interval from 85 to 86 Solar years, the degrees pass from 29 to 30; and the signs from 1 to 3; and as the signs represent years of the Planet, it is clear that between 85 and 86 years the name of one of the Chacra is to be omitted.

In order to ascertain the precise period in Solar time, multiply the duration of one Solar

year - - - - - -		365^D	15^d	31^p	31^c
	by			×	86
⊙ sum of days - - - -		31412	15	10	26
And the duration of 1 of ♃'s year (page 199) -		361	2	4	44,23293
	by				87
♃'s sum of days - - - -		31410	0	52	8,26501
⊙ sum of do. - - - -		31412	15	10	26
Difference -		2	14	18	17,73499

which difference answers to 11′ 9″ 36‴ of Longitude in degrees above found (vide Table XIII, page 16 of the Tables).

It appears therefore, that 86 Solar years answer to $87^Y\ 2^D\ 14^d\ 18^p\ 17^c$,73499 &c. of Jupiter's time (the days, dandas, &c. expressed in Solar time,) and that 7ʳ 3ˢ 0° 11′ 9″ 36‴ of his motion in Longitude have a constant ratio to the period of recurrence of the expunged year.

Let ♃'s Longitude at the end of the Solar year Cali yugam 4871, computed by Table XI and

XII be, with the number of his expired revolutions - -		410ʳ	7ˢ	29°	43′	15″	36‴
	add				16	44	24
You have 8 signs without a remainder -		410	8	0	0	0	0

Now 16′ 44″ 24‴ (Table XIII) answer to $3^D\ 21^d\ 27^p\ 26^c$,4027 of Solar time very nearly.

It follows therefore, that a *Cshaya* or expunged year will be due in the Solar year 4872 current, when $8^D\ 21^d\ 27^p\ 26^c$ of the month Chaitram have expired.

To the Solar year 4871, add 86 years, the sum will be 4957 complete.

To ♃'s Longitude above found	- - - -	410^r	7^s	29°	$43'$	$15''$	$35'''$
Add for 86 Solar years (Table XI)	- - - -	7	3	0	11	9	36
♃'s Longitude at the end of 4957	- - -	417	10	29	54	25	12
	- add				5	34	48
You have 11 signs without a remainder	-	417	11	0	0	0	0

But by Table XIII, $5'\ 34''\ 48'''$ answer to $1^D\ 7^d\ 9^p\ 8^c$,8000, therefore the expunged year was due in the Solar year 4958 current, when $1^D\ 7^d\ 9^p\ 8^c$ of the month Chaitram had expired.

	y.	D.	d.	p.	c.
Hence, as the 2d Cshaya was due in	4958	1	7	9	8,8000
		(365	15	31	31)
	4957	366	22	4	39,8009
And the 1st in - - -	4872	3	21	27	26,4027
	85	363	1	13	13,3982,

which reduced into Jupiter's time by Table XVII, page 18, will be

Solar.		Of Jupiter.				
	y.	y.	D.	d.	p.	c.
Column 2,	80 - - -	80	337	55	42	21,2416
	5 - - -	5	21	7	13	58,8274
		+	363	1	13	13,3982
		2)	722	4	9	28,4672
One year of Jupiter, page 199	- - -		(361	2	4	44,2336)
Sum of ♃'s years	- - - -	87	0	0	0	0

Period of the Cshaya 85y 363D 1d 13p 13c,3982.

Therefore $85^y\ 363^D\ 1^d\ 13^p\ 13^c$,3982 &c. of Solar time, answer precisely to 87 years of Jupiter's, and the former quantity marks *in Solar time* the period when one of Jupiter's years is to be expunged. This is the quantity which governs Table XVIII, page 20, where the Epoch of every *Cshaya* due since the beginning of the Cali yug is exhibited. (*)

It need hardly be hinted that the Equation $16'\ 44''\ 24'''$ added to the process for the year 4871, and $5'\ 34''\ 48'''$ for the year 4957, when added together amount to $11'\ 9''\ 36'''$, the common excess of ♃'s Longitude over 3 signs in 86 Solar years, as has been shewn at page 206.

In the preceding Examples, as the degrees of ♃'s Longitude did not amount to a whole sign when the Solar year began, the *Cshaya* was due in the beginning of the following Solar year: but if we continue as before for the next period, viz.

			R.	S.	°	′	″	‴
Revolution and Longitude A. C.	4957	- -	417	10	29	54	25	12
	86	- -	7	3	0	11	9	36
	5043	- -	425	2	0	5	34	48

(*) The mean difference used in that Table is 85y 363 1 13 13,3989, differing from the above $\frac{7}{10000}$.

As the minutes, seconds and thirds exceed a complete sign (whereas the same quantity was wanting from it in the preceding Example), it shews that the *Cshaya* was due before the end of the Solar year 5043; and that the interval of time wanting to reach it, is that which answers to 5′ 34′ 48″, viz. 1^{D} 7^{d} 9^{p} 8^{c},8009: so that the precise Solar Epoch is A. C. 5043^{y} 36 1^{D} 8^{d} 22^{p} 22^{c},1991.

By help of these observations, the construction and use of the Tables from XI to XVIII may be easily understood and demonstrated.

I shall now turn to the consideration of the periods of the expunged years of the Chacra according to the *Jyautistava* account, the theory of which is rather more intricate than that of the foregoing style.

Of the expunged year according to the Rule of the Jyautistava.

Periods of Jupiter according to the Aria Siddhanta 4370688 revolutions in a Maha yug.

We have already observed (page 202) that the Jyautistava follows the periods of the Aria Siddhanta, which assigns 4370688 revolutions of Jupiter in a Maha yug, or 4320000 mean Solar Sydereal years, the duration of each being 365^{D} 15^{d} 31^{p},25. It appears, however, that the author of the rule has occasionally warped these quantities, so as to make them fit his system, which represents the duration of one year of ♃ to be equal to $\frac{1375}{1875}$, and which fraction serves to express the different circumstances of the Problem.

Jupiter's year 355 49 29,95255 in Saura, and 361 1 21,65194 in mean Solar Sydereal time, for which see Table XVI, page 18.

From what precedes, Jupiter's year is $\frac{4320000}{4370688} = 0^{y}\ 11^{m}\ 25^{D}\ 49^{d}\ 29^{p}$,95255, &c. or 355^{D} 49^{d} 29^{p},95, &c. expressed in *Saura* time of 360 days in the year.

In order to have the same expressed in Solar Sydereal time, say, as 360^{D} : to 365^{D} 15^{d} 31^{p},25, so is 355 49 29,95255, &c. to 361^{D} 1^{d} 21^{p},6496, which is the duration of the Vrihaspati year according to the Aria Siddhanta.

It will be shewn however, presently, that the Jyautistava takes the Vrihaspati year nearer to 355^{D} 49^{d} 30^{p},418604, &c. of Saura time, the difference being 0^{p},466050, and that in one of its Equations, it retrenches 2^{p},03239, &c. from the duration of the same, for no other purpose, that I could discover, than to fit the theory to the rule.

Of the occasion of the Cshaya year.

Of the occasion of the Cshaya.

Let the circumstances of the Vrihaspati year concurring with A. C. 4858 or 1679 Saca, be computed; there will be $\frac{1679 \times 22 + 4291}{1875} = 21\frac{1854}{1875}$ and $\frac{1679+21}{60} = 28\frac{20}{60}$.

Use Table XIV, page 16.

The 1st term reduced into Saura time will give 21 years, 11^{m} 25^{D} 58^{d},4, by which quantity (at that period) the Vrihaspati had advanced before the Solar time, and the last member of the rule shews that 28 cycles and 20 years had elapsed since the Epoch. *Vijaya* was therefore, the last expired year, being the 20th of the Chacra, and *Sarvajit* the 21st, the current one, of which the above number of Saura months and days had expired on the 1st Chaitram (Bengal Vaisácha), or the beginning of the Solar year 1680.

Compute now for the ensuing year Cali yug 4859, or 1680 Saca.

$$\frac{1680 \times 22 + 4291}{1875} = 22\,\frac{1}{1875} \text{ and } \frac{1680 + 22}{60} = 28\,\frac{22}{60}.$$

Here it will be perceived, that the first member has passed from 21 $\frac{1854}{1875}$ to 22 $\frac{1}{1875}$ and the second from 28 $\frac{20}{60}$ to 28 $\frac{22}{60}$, the numerators of the last fractions 20 and 22 shewing that in the space of one Solar year, *one* of the Chacra is to be passed over: Hence, on the beginning of the Solar year 1681 the last *Vrihaspati* year expired is not *Sarvadhari* the 22d, but *Virodhi* the 23d.

Again, as in the computation for 1679 the fraction of the 1st member was $\frac{1854}{1875}$, which answered to $11^m\ 25^D\ 58^d,4$ Saura time expired, there wanted only $4^D\ 1^d\ 56^p$ for reaching the commencement of the next Chacra year *Sarvadhari*.

But in the rule for 1680, the fraction of the 1st term was $\frac{1}{1875}$ answering to $11^d\ 31^p,2$ Saura time already elapsed on the 1st Chaitram since the year *Sarvadhari* had *ended*. Hence the whole Cause of the Cshaya. of the Chacra year *Sarvadhari* was expended during the Saca year 1680 current, on which account (like the Lunar Tidhis which begin and end in the same Solar day in the Chandra Mana) that year is expunged out of the Kalendar.

In order to account for that circumstance, we shall consider generally the period of recurrence Illustration. of the expunged year.

For the periods of the Cshaya:

It is to be observed that, the only variable quantity of the first member of the rule is the numeral of the Solar year for which the time is computed, and as that quantity is always multiplied by 22, it follows that the first term increases yearly by $\frac{22}{1875}$, and if we raise this quantity by 86, the first term will increase by $(86 \times \frac{22}{1875})$ 1y $\frac{17}{1875}$ in 86 years.

Thus if we compute for the years Saca 572 and 658, we shall have for 86 Solar years

$$\text{1st.}\quad \frac{572 \times 22 + 4291}{1875} = 9\,\frac{0}{1875} \text{ and } \frac{572 + 9}{60} = 9\,\frac{41}{60}.$$

$$\text{2d.}\quad \frac{658 \times 22 + 4291}{1875} = 10\,\frac{17}{1875} \text{ and } \frac{658 + 10}{60} = 11\,\frac{8}{60}.$$

$$\begin{array}{lrrl} \text{2d.} & (11^\circ\ 8^\prime \text{ or})\ 10^\circ & 68^\prime + & \frac{17}{1875} \\ \text{1st.} & 9 & 41 & \frac{0}{1875} \\ \hline \text{Difference} & 1 & 27 & \frac{17}{1875} \text{ or } 87^\prime\ \frac{17}{1875}. \end{array}$$

Therefore 86 Solar years answer to 87 $\frac{17}{1875}$ *of the rule*, and subtracting the fraction from both, we have 85 $\frac{1858}{1875}$ and 87 years, which however, must not be taken to be exactly 87 years of the Planet, as shall be shewn presently.

The fraction $\frac{1858}{1875}$ being converted into time (Table XIV, page 16) will answer, together with the years, to $85^y\ 356^D\ 44^d\ 9^p,6$, and this is one of the periods which will serve for finding the Epoch of any other expunged year, *that* of any one being given.

1st period, 85 $\frac{1858}{1875}$
or $85^y\ 356^D\ 44^d\ 9^p,6$
or 85 361 56 49,206
in Solar time.

The other period requisite for the general resolution of the problem, is the time due to 86 of

2d period, 85 $\frac{5}{1875}$ or 85y 0D 57d 36p i. e. 85y 0D 58d 20p,48932 in Solar time.

Jupiter's years, which being one less than the preceding, may be obtained by subtracting from the integer the annual increase or $\frac{1875-22}{1875} = \frac{1853}{1875}$. This quantity subtracted from the first period, viz. $85 \frac{1858-1853}{1875} = 85 \frac{5}{1875}$, will give the period sought; and the fraction $\frac{5}{1875}$ answering to $57^d\ 36^p$, will be *in Saura time* 85y 0D 57d 36p precisely *according to the rule.* (*)

Resolution of the Epochs.

By means of the two periods above determined, the recurrence of the expunged year may be found with precision according to the Jyautistava account.

EXAMPLE.

Let the given Epoch be that calculated at page 209, by means of the year Saca 572, where the fraction of the 1st member being zero, shews that the commencement of the Solar and Vrihaspati years were simultaneous. We shall have the following series.

$$
\begin{array}{llllllll}
 & & & & \text{y.} & \text{D.} & \text{d.} & \text{p.} \\
 & \text{Y.} \qquad\qquad \text{Y.} & & \text{Y.} & 572 & 0 & 0 & 0. \\
572 + & \left\{ \begin{array}{l}
85 \quad \frac{1858}{1875} = 572 + 85 + \frac{1858}{1875} \\
2\times 85 \quad \frac{5}{1875} = 572 + 170 + \frac{1858+5}{1875} \\
3\times 85 + 2\times \frac{5}{1875} = 572 + 255 + \frac{1858+10}{1875} \\
4\times 85 + 3\times \frac{5}{1875} = 579 + 340 + \frac{1858+15}{1875}
\end{array} \right. &
\begin{array}{l}
= 657 \frac{1858}{1875} = \\
= 742 \frac{1863}{1875} = \\
= 827 \frac{1868}{1875} = \\
= 912 \frac{1873}{1875} =
\end{array} &
&
\begin{array}{l} 657 \\ 742 \\ 827 \\ 912 \end{array} &
\begin{array}{l} 356 \\ 357 \\ 358 \\ 359 \end{array} &
\begin{array}{l} 44 \\ 41 \\ 39 \\ 36 \end{array} &
\begin{array}{l} 9,6 \\ 45,6 \\ 21,6 \\ 57,6 \end{array}
\end{array}
$$

Saura time,

where the 1st period (of 87 Chacra years) has first been added to the Epoch A, S. 572, and then the 2d (of 86 C. years) added in succession so long as the fraction does not exceed unity or $\frac{1875}{1875}$.

In the present case the fraction amounting in A. S. 912, to $\frac{1873}{1875}$ cannot evidently be increased by $\frac{5}{1875}$ without exceeding unity, as was the case at the preceding periods: Hence, the last resolution A. S. 912 $\frac{1873}{1875}$ becomes a new Epoch, to which the first equation is again to be applied; the remainder of the fraction to unity being $\frac{2}{1875}$.

(*) That these periods of Jupiter's revolutions are only *true*, relatively to the Rule, will appear from multiplying his year according to the Aria Siddhanta (above determined) by 86 and 87.

$$355D\ 49d\ 29p{,}95255 \times \begin{array}{l} 86 = 85y \quad 0D\ \ 56d\ \ 55p{,}91930, \ \&c. \\ 87 = 85 \quad\ 356\ \ 46\ \ 25{,}87185, \ \&c. \end{array} \Big\} \text{ Saura time.}$$

N. B.—In the following Examples I have preserved the *Saura* in preference to the *Solar* time, because the fraction is easily reducible to it by means of Table XIV.

For the succeeding Epochs we have, therefore,

$$912 + \left\{\begin{array}{lclcll} \text{Y.} & & & \text{Y.} & & \text{Y.}\quad \text{D.}\quad \text{d.}\quad \text{p.} \\ & \text{Epoch} & & 912 & \frac{1873}{1875} = & 912 \quad 359 \quad 36 \quad 57{,}6 \\ 85 + & \frac{1858+1873}{1875} & = & 998 & \frac{1856}{1875} = & 998 \quad 356 \quad 21 \quad 7{,}2 \\ 170 + & \frac{1858+5+1873}{1875} & = & 1083 & \frac{1861}{1875} = & 1083 \quad 357 \quad 18 \quad 43{,}2 \\ 255 + & \frac{1858+10+1873}{1875} & = & 1168 & \frac{1866}{1875} = & 1168 \quad 358 \quad 16 \quad 19{,}2 \\ 340 + & \frac{1858+15+1873}{1875} & = & 1258 & \frac{1871}{1875} = & 1258 \quad 359 \quad 13 \quad 55{,}2 \end{array}\right.$$

Saura time,

where the period for the year Saca 998 has been found by adding 912 $\frac{1873}{1875}$ to 85 $\frac{1858}{1875}$ the 1st equation (page 210) $= 912+85+1+\frac{1856}{1875} = 998\ \frac{1856}{1875}$, and the subsequent ones by adding 85 $\frac{5}{1875}$ for each interval to 912 $\frac{1873}{1875}$.

Here again the last fraction warns us that the series can be carried no further, the remainder to unity being $\frac{4}{1875}$ and the periodical increase being $\frac{5}{1875}$. Therefore a new Epoch must again be determined by adding 85′ $\frac{1858}{1875}$ to 1258 $\frac{1871}{1875}$, as we have done in the preceding case.

And thus the periods, when a Chacra year is to be expunged, may be calculated ad infinitum without the least error.

N. B.—The series of Epochs the difference of which is 86 Chacra years, and which in the two preceding Examples extend only to *four*, may in some cases amount to *five*; which circumstance depends on the fraction approaching sooner or later to unity. Thus if the foregoing periods be carried on, by the same rule, the 4th period from the last Epoch will be 1594 $\frac{1862}{1875}$ and the fraction admitting of a farther increase by $\frac{5}{1875}$ without reaching unity, the next will be 1679 $\frac{1874}{1875}$, wanting only $\frac{1}{1875}$ from it, and therefore occasioning a new Epoch.

General Observations.

Concurrence of the Siddhanta and Jyautistava Chacra years.

As it has been customary from time immemorial in Southern India, to annex the name of the Vrihaspati year to all dates expressed in Luni-solar time, and as the Jyautistava rule which is followed in some countries gives Epochs for expunged years greatly different from those of the Surriah Siddhanta, I have taken some pains to investigate the mechanical operation of the rule of the former with a view to establish the difference of their Epochs, and this will be found in Table XIX, p. 23, where the Epoch of every expunged year according to the two Styles, has been computed since the Epoch of Salivahana, beyond which the Jyautistava account does not ascend.

Table XIX, page 23, shews that whereas in the year of the Cali yug 3239, or Saca 60, the Jyautistava account placed the Cshaya *two* years *later* than the Surriah Siddhanta, in the present time, on the contrary (1679 Saca) it falls 13 years earlier.

Concurrence of the Siddhanta and Telinga Chacra years.

For the years of the Chacra according to the Tellingas relatively to those of the Sastra's style, see page 205, where it is shewn that in the 4870th of the Cali yug the former was slower by 56 years, the number of expunged years since the commencement of the yug, an equation unknown to the Tellingas.

On the concurrence of the Vrihaspati *and Christian years.*

Concurrence of the Vrihaspati and Christian years.

Lastly, with regard to the concurrence of the Christian years with those of the Chacra, although we have been compelled for the sake of arrangement to annex the numeral of the Christian year which coincides most with the Hindu Solar years, to the beginning of which the time elapsed of the Vrihaspati *year* is referred, yet it is sufficiently obvious from what has been stated in the first part of this article, that it may be very near ending when the former is about to commence; in which case there would be so much of the *Vrihaspati* year elapsed on the Christian date on which the Hindu Solar year begins (which for a long time past has been in the month of March, *Julian style)*, that the said *Chacra* year would more properly be coupled with the preceding Christian year than the former.

Thus on the 1st Chaitram of the Solar year 4871 from the Cali yug current, there remained, according to the rule of the Surriah Siddhanta, only 7 days to run of the Chacra year *Vicari* (362^{d} 2'—353^{d} 17')—but the said Solar year began on the 9th April 1769; therefore the greatest part of Vicari from its beginning elapsed in A. D. 1768. But the custom has always been to couple the name of the Vrihaspati year, at whatever period it may begin, with that of the Solar years from whose commencement that of the former is deduced. Now as A. D. 1769 is considered mainly to coincide with A. Cal. 4871 *current* (4870 ending in the said Christian year), so is Vicari, the Chacra year under consideration, coupled with 1769; and thus Mr. Davis has found that the year of Christ 1784 corresponded with *Ananda* and *Racshasa* the 48th and 49th years of the Chacra (*); but this double notation would be attended with so much inconveniency, that I have seen it used no where.

On the Vrihaspati Cycle of twelve years.

On the Vrihaspati Cycle of 12 years.

In the Cycle of sixty are contained 5 Cycles of twelve years, each supposed equal to one year of the Planet. I only mention this Cycle because I found it mentioned in some books, but I know of no nation or tribe that reckons *time after that* account.

The names of the five Cycles, or Yugas, are as follows :

Names.			Presided by
1. Sumvatsara	-	-	Agni.
2. Parivatsara	-	-	Arca.
3. Iduvatsara	-	-	Chandra.
4. Anuvatsara	-	-	Brahma.
5. Udravatsara	-	-	Siva.

(*) Asiatic Researches, Vol. III, p. 215.

The name of each year is determined from the Nacshatra in which Vrihaspati rises and sets heliacally; and they follow in the order of the Lunar months.

The years beginning with the mouth *Cartic* commences with the Nacshatra *Critica*, and to each year there appertains two Nacshatras, except the 5th, 11th, and 12th years, to each of which belongs three Nacshatras. These are arranged in the following order:

	Months beginning years.	Nacshatras.		Months beginning years.	Nacshatras.
1	Cartic	Criticà, Rohini	7	Vaisácha	Visac'ha, Anurádhà
2	Agrahayan	Mrigasiras, A'rdrà	8	Jyaishtá	Jyést'ha, Mula
3	Paushia	Punarvasu, Pushia	9	Ashar	P. A'shád'hà, Ut. A'shád'hà
4	Mágha	Asleshà, Maghà	10	Srávana	Srávana, Dhanish'tà
5	P'ha'lguna	P. Phalguni, Ut. Phalguni, and Hasta	11	Bhádrapada	Satabhisha, P. Bhádrapada, Ut. Bhádrapada
6	Chaitra	Chitra, Swáti	12	A'swina	Revati, A'swini, Bharani.

It may be remarked that in the foregoing arrangement *Cartic* is placed the first in the Cycle of 12. It may therefore be inferred, that there was a time when the Hindu Solar year, as well as the *Vrihaspati* Cycle of 12, began with the Sun's entrance in, or near the Nacshatra *Critica*.

It follows also from this, that the first year of the Cycle of 60, begins in the Lunar month Cartic. But the Southern Indians, if they ever did, have long since ceased to attend to the months of the Chacra year.

Tables for computing the year of the Chacra.

The Tables, from the XIth (page 15) to the XIXth (page 23 of the Tables) were constructed for the purpose of abridging all the operations disclosed in the preceding pages: which, independently of their being very tedious from the constant reduction of one sort of time to another, or degrees into time, expose the computer to frequent mistakes. It is to be remembered that the Tables which refer to the Surriah Siddhanta take the Solar year to be 365D 15^{d} 31^{v} 31^{p},24 and those which refer to the Aria Siddhanta 365^{d} 15^{g} 31^{v} 15^{p}.—And furthermore, that the duration of Jupiter's year according to the former is 361^{d} 2^{g} 4^{v} 44^{p},2 &c. and to the latter 361^{d} 1^{g} 21^{v} 39^{p},1 &c. in mean Solar Sydereal time, as has been shewn in the course of this Memoir.

There will be found annexed to Table XVIII (page 20 and following) a variety of Examples of the application of all the rest, which supersedes the necessity of adding any thing here on the subject of these Tables. (*)

POSTSCRIPT.

From the preceding investigation we derive a Rule, which will be found very convenient for finding the Chacra year answering to any proposed Christian or Hindu Solar year.

(*) The names and numerals of the years of the Chacra will be found in the General Solar Table at the end of the volume.

PRECEPT.

Short Rule for eliciting the Vrihaspati year, and its rank in the Cycle of 60.

"If the Christian year be proposed, find the corresponding one of the Cali yug by adding "3101 thereto, the sum will be the last year expired of the same.

Precept.

"Divide the expired years of the Cali yug by 86; add the quotient to the dividend; divide "again the sum by 60, the quotient will give the number of Cycles expired, and to the remainder, "if the proposed year be *less than* 31 from the last expunged year of the Chacra (found in Table "XVIII), *add* 28, and if it falls *in the* 55 remaining years of the Cycle of 86, *add* 27, and the "sum will be the numeral of the year current of the Chacra.

EXAMPLE 1.

Let A. D. 1600, answering to A. C. 4701 complete, be proposed.

Examples.

By Table XVIII we find that the last expunged year fell on A. D. 1598
1600

Year of the Cycle of 86 years - - 2

1º	2º
Then - 86)4701(54	4701
401	54
57	60)4755(79
	555
	15
	28
	43 Saumya.

Here we have added 28, because the proposed year was the second of the Cycle of 86 years.

EXAMPLE 2.

Let A. D. 1824, answering to the 4925th year of the Cali yug complete, be proposed.

By the Table XVIII the last expunged year of the Chacra fell on A. D. 1770
1824

Year of the Cycle of 86 years - - 54

1º	2º
86)4925(57	4925
625	57
23	60)4982(83
	182
	2
	27
	29 Manmat'ha.

Here we added 27, because the proposed year exceeded the 31st of the Cycle of 86 years.

EXAMPLE 3.

Let A. D. 0, answering to the 3101st of the Cali yug complete, be proposed.

By Table XVIII the last expunged year of the Chacra fell on A. A. C. 36, which marks the rank of the proposed year in the Cycle of 86 years.

```
    1°.                   2°.
86)3101(36               3101
    521                    36
    ---                  -----
      5              60)3137(52
                          137
                          ---
                           17
                           27
                          ---
                           41  Sadharana.
```

Here again we added only 27, because the year proposed was the 36th of the Cycle of 86 years, exceeding 31.

The reason of this operation may be explained as follows :

As the parts or fractions of years are neglected in the short Rule, the expunged years resulting from the same do not coincide with those of the Sastra rule; although both be governed by the Cycle of 86 years.

```
66)4901(56
    601
    ---
     85

   4901
     56
   ----
60)4957(82 years.
    157
    ---
     37
     27
    ---
      4
```

For instance, let the Christian year 1800 answering to 4901 of the Cali yug complete, the remainder 85, after division by 86, shews that the quotient 56 will increase by *one* on the next Solar year; and therefore, that a Chacra year will be expunged.

But by Table XVIII we find that the last expunged year of the Chacra according to the Sastra, falls on A. D.

```
1770
1801
----
  31
```

that is to say, 31 years before.

So that until then the results by the Sastra, preceded that of the short Rules by one year.

```
86)4902(57
    602
    ---
      0

   4902
     57
   ----
60)4959(82
    159
    ---
     39
     27
    ---
      6
```

But as in 1801, or 4902 of the Cali yug complete, the quotient after division by 86, increased by *one*, and as there was zero for remainder, it follows that the remainder after division by 60, increased by *two;* and therefore, one year of the Chacra must be expunged; that is, the numeral in the series will be increased by one; so that from the said year, to the end of the Cycle of 86 years (55) the results of both Rules will agree.

Having thus found the manner of expounding quickly the year of the Chacra, from that of the Cali yug according to the precepts of the Surriah Siddhanta, we may easily deduce that which is elicited by the Jyautistava rule by a comparison of Tables XVIII and XIX.

END OF THE THIRD MEMOIR.

FOURTH MEMOIR.

ON THE
LUNAR YEAR
OF THE
MAHOMMEDANS.

Written in A. D. 1814 ; *Revised in* 1823.

MEMOIR

On the Lunar year of the Mahommedans and on the Æra called Hejira.

On a subject so fully explored as that of the Lunar year used throughout Islaanism for the purposes of civil life, independently of all sects and geographical positions, it would be vain to pretend to offer any thing new: the occasion of this paper could therefore only arise from particular circumstances. Thus being lately engaged in a research which required the knowledge of the Christian dates concurring with those of the Hejira, and not having been able to procure any Treatise or Tables that could give me assistance, I prepared the Elements of the present Note for my own use, but without the least intention of communicating it to the public. Being lent, however, to a learned friend (*) who, like myself, wanted access to the Mahommedan Kalendar, the original tract, (which contained only a few practical rules for finding the conjunctions on which the beginnings of the Civil years and months of the Hejira, depend) acquired in his hands a public existence for which it never was intended, and in consideration of this unexpected distinction, I was induced to give it subsequently its present form and extension: although, for reasons already stated, I forbore entering into the particulars of a theory which is familiar to every student in Chronology.

When on the revival of the sciences in Europe, the Arabs were resorted to for the embers of that hallowed fire which the Kalif Omar had extinguished, the works of Almamon (1), Alfragan (2), Thebith-Ben-Chora (3), Albategni (4), Arzachel (5), Alhazens (6), and others, drew the attention of all the votaries of science; and even afterward, when its light began to dawn again on the West of Europe, the works of Ulug-Beg (7) proved a further and fertile source of information. It is universally admitted, that we owe to that successful appeal to the labours of the Arabian Astronomers, some of the most ingenious discoveries in modern Astronomy: but to reap this harvest, it was indispensable to find means for reducing the observations which they had recorded according to their particular account of time, to the concurrent dates of the Christian Kalendar, and that work, which was not without considerable difficulties, was performed by the most celebrated Mathematicians of successive ages. Melancton, Christman, Bianchini, Snellius, Gravius, F. Peteau, F. Riccioli, Wolfius and others, have left nothing to add to their researches. (†) What follows, is a short abstract of their labours.

A. D. 1300.

(1) Son to Aaron-al-Rashid, ascended the throne A. D. 814.
(2) 800.
(3) 850.
(4) 880.
(5) 1080.
(6) 1130.
(7) 1430.

(*) The late Mr. Ellis.

(†) Vide Gravius in commentary on Ulug-Beg; Christman on Alfragan; F. Peteau in his 7th Book "De "Doctrina Temporum;" F. Riccioli's Reformed Chronology; and the Elements of Mathematics of Wolfius.

Common Epoch of Hejira 16th July 622.

By most Arabian Astronomers 15th July same year.

Every one knows that the Epoch of Hejira, or flight of Mahommed from Mocha to Medina, from which all Moslems reckon their Civil year, was found to concur with Friday, the 16th July, A. D. 622.—A certain sect of Islaamites, however, (of which were most of their Astronomers) reckoned it from the preceding day; i. e. Thursday, the 15th of July of the same year; a circumstance not to be forgotten when reading their ancient authors. (*)

Epoch referred to other accounts of time.

It was established that the first year of the Æra was the 5335th of the Julian period;—Solar Cycle 23—Lunar Cycle 15—Cycle of Indiction 10—and of the Æra of Nabonassar (the current year of which began on the 21st March preceding) the 1370th.

Common Lunar Synodical year of the Arabs.

The Lunar year was found to consist of 354 days, $8^h\ 48'\ 36''$, and the Lunar Synodical month of 29 days, $12^h\ 44'\ 3''$. So that the Mahommedan year falls short of the Julian by 10 days, $21^h\ 11'\ 24''$ (nearly 11 days); from which it follows that 12 Julian years are equal to 12 years, 130 days, $14^h\ 16'\ 48''$ Mahommedan reckoning; and 12 Tropical years are equal to 12 years, 130 days, $12^h\ 1'\ 48''$ of the same.

The Lunar year, month and day, begins immediately after Sun set.

With these data there was no difficulty for finding the concurring Astronomical periods of both styles: but this would not have been sufficient for understanding the Arabian authors, who had recorded their observations according to the *Civil* Kalendar used in their own time and country. And as the Arabs had made their Civil day, month and year, begin in the evening immediately after Sun set, on the day after the conjunction, when the Moon's crescent began to be visible, it was found necessary to analyze the system on which their Kalendar had been established, and to understand how the mode of assigning the unequal duration of the Civil months, and of intercalating the Civil years, which they had adopted, made each so to keep pace with the Moon's Synodical revolutions, that the beginning of every month always followed the conjunction by the least time necessary for the Moon to become again visible. This was the part of the problem which tried the skill of the European Astronomers: but with which we have at present nothing to do; what follows, being perfectly sufficient for all practical purposes.

Cycles of thirty years.

The Arabs divide time into Cycles of 30 years, 19 of which are called *common*, and consist of 354 days, and 11 are called *intercalary*, which are of 355 days. The latter, in the order of the Kalendar, are the 2d; 5th; 7th; 10th; 13th; 16th; 18th; 21st; 24th; 26th and 29th of the Cycle.

The years of 12 Lunar months, and the months alternately of 30 and 29 days. The last month consists of 30 days in the intercalary years.

The year of Hejira is divided into 12 Kalendar months, which consist alternately of 30 and 29 days; excepting the last month, which in the intercalary years consists of 30 days.

The months are also composed of four weeks, and 1 or 2 days, which differ in nothing from ours.

(*) Vide observation, page 32 Infra.

The names of the months are as follows :

		Days.			Days.
1	Mahorum	30	8	Shahaban	29
2	Suffr, or Sepher	29	9	Rhamadan ; or Ramazan	30
3	Rabi-el-Avul	30	10	Shawal	29
4	Rabi-el-Aukeer, or Sanee	29	11	Zoolcada; or Zoolcayadah	30
5	Giumadi ; or Giumaasil el-Avul	30	12	Zooledgee ; or Zoolcagiadah	29 or 30
6	Giumadi ; or Giumaasil el-Aukeer	29			
7	Regeb, or Regihab	30			

which last month in intercalary years counts 30 days.

The names of the days of the week are,

The Arabic names of the days of the week are numerals; first, second, third, &c.

Indian Names.		*Arabic Names.*	
Etwar	1	Yoom-el-Ahad	Sunday
Peer	2	Yoom-el-Thani	Monday
Mungul	3	Yoom-el-Thaleth	Tuesday
Char Shumbol	4	Yoom-el-Arbaa	Wednesday
Jummah Rhaut	5	Yoom-el-Kamis	Thursday
Jummah	6	Yoom-el-Dgiooma	Friday
Avul Haftah	7	Yoom-el-Effabt	Saturday

Roots of years and months, the day of the week on which each begins.

Arabian Astronomers call the weekly day or feria by which the year or month commences, the *Character* or *Root* of the said year or month ; so that in the Mahommedan Kalendar each year and month has its peculiar Root or Character, which serves to find their succession, as shall be explained hereafter.

Thus much it was necessary to disclose of the construction of the Mahommedan Kalendar to render the third General Table, and those numbered L and LI, intelligible. The process for determining the root, and initial feria of every month and year (to begin from the evening of the 16th July A. D. 622, and continue to any subsequent month and year) is fully explained at page 224 of this Memoir.

Explanation *and* use *of the* Tables *which refer to the* Mahommedan year.

Of the General Table III *of this collection, being the 1st for this Memoir.*

Disposition of the General Table III.

This Table gives the beginning of every year of the Hejira from A. H. 1 to 1318, and the Christian concurrent years from A. D. 622 to 1900, according to the Gregorian and Julian styles. It differs from other Tables of the same kind (of which there are several) only in the arrangement of the years, which are here disposed according to their respective roots, or initial feriæ ; the figures 1, 2, 3, 4, 5, 6, and 7 in the transverse column at top, indicating that all the years registered under each respectively, begin on a Monday, Tuesday, &c. which roots are indispensable for finding the commencement of the 11 last months of the year. I have preferred this arrangement to the more natural one of following the series of numbers, from local circumstances; and because it facilitates a reference to the beginning of Hindu years of all styles, which like those of the Hejira, are elicited by their initial feriæ: so that in many cases their beginnings may be compared or verified by mere inspection. The inconveniency resulting from the interruption of the series, which retards a little the finding of the year sought, is more than compensated by the advantage of avoiding the possibility of mistaking the roots; for the initial feria is known the instant the year is found.

B indicates an intercalary year.

The letter B affixed to any particular year of Hejira, indicates that *it is one of the eleven* intercalaries of the Cycle of 30 years, and that it consists of 355 days.

* that the year is the last of the Cycle of 30 years.

The asterisk * and stroke = above and below the same year, indicates that it is *the last* of the Cycle of 30 years, and that the intercalations begin anew from that period, according to their permanent order.

Concurring years of the Cali yug and Saca how noticed.

Each page contains a century of Christian years, and its number is indicated at the top of it. In the margin on each side is entered the first and last concurring years of the Hejira; of the Æra Cali yugam, and from the birth of Salivahana, usually called Saca.

In those particular cases where the Mahommedan year begins and ends in the same Christian year (or, which is the same thing, when two years of the Hejira begin in the same Christian year), the commencement of both is inserted in the column of the root *proper to one* of the said two years; so that the other is out of its place; on which account its own character is affixed to it, and these years are repeated twice in the same page. Thus we find A. D. 1258 in the first and third column of the page containing the 13th century, because the roots of A. Hejira 656 and 657 are 3 and 1, and that the beginning of both fell in the said year of Christ 1258. I have preferred repeating, to separating these years; because the former method gives a warning which may prevent troublesome mistakes.

From the year 1582, when the Gregorian style was introduced on the Continent of Europe, the notation is registered according to both styles, which was found necessary, because the new one only obtained in England in the years 1752. What remained of years to reach the end of the 19th century, was not of sufficient consequence to alter again the form of the Table. The commencements of the years of the Hejira continue therefore to be given till the end, according to old and new style.

Example I.

How to find the Christian year corresponding with any of the Hejira by Table III.

Thus if I want the Christian year concurring with that of the Hejira 271, I look into that page of the General Table III, where 184 (the nearest below that year at the top of any page) is registered in the margin; and finding that it falls in the 9th century and in the column, the root of which is 2, I conclude that it concurs with A. D. 884; that the 1st Mahorum of that year fell on Yoom-el-Thani (Monday) the 29th June O. S.; and lastly, as the notation of the Mahommedan year bears no B, that its last month *Zooledgee*, consists only of 29 days, the year being a common one.

EXAMPLE II.

How to find the year of Hejira corresponding to any Christian year by the same Table.

But if the Christian year 1824 be proposed, and the beginning of the concurrent Mahommedan year be wanted, referring to the same Table where the 19th century is indicated, I find the given year to concur with A. H. 1240, under the root 5, which shews that it begins on a Thursday (Yoom-el-Kamis), and as its notation bears a B, it is a sign that the year is an intercalary one, and therefore, that the last month, *Zooledgee*, consists of 30 days.

For finding the beginning of the intermediate months of the Mahommedan year, by help of the General Table III, it is supposed that the Dominical Letter is known. But although it be not expressed on its face, it may quickly be deduced from the European date and character which indicates the commencement of the year of Hejira.

EXAMPLE III.

How to find the Dominical Letter by means of the General Table III.

For as we have found that the year of Hejira 1240 will begin on the 14th of August *Julian* and 26th *Gregorian* styles A. D. 1824, and as the root for that Mahommedan year was 5 (Yoom-el-Kamis, or Thursday), on referring to any Kalendar wherein the Dominical Letters are inserted, and taking the 14th August to fall on a Thursday, we find, (counting three days therefrom) that the Sunday following corresponds to the Letter E, which is therefore the second Dominical Letter of that *Bissextile* year, and F the first according to the *Julian style*.

In the same manner the 26th August falling on a Thursday, the Letter opposite to the next Sunday will be found to be C, the second, and D the first Dominical Letter according to the Gregorian style.

But as it seldom happens that the beginning and end of the same year of the Hejira falls during the course of the Christian year in which it begins, the Dominical Letter of the ensuing one is almost always required: but it is sufficiently known to be the preceding one in the order of the alphabet to that previously found.

Of TABLE L, *being the second for this Memoir.*

As the General Table III only gives the root of the year and Mahorum, it was necessary to establish some means for obtaining that of the remaining months of any proposed year, from which the particular dates might be deduced.

Construction of Table L.

For this purpose a Table was constructed by *Gravius* on the following principle.

As the twelve months of the Lunar year are alternately of 30 and 29 days, the latter begin and end on the same weekly day or feria; and the former end on the next to that on which they began.

Its use.

Thus when the month of *Mahorum*, which consists of 30 days, begins on the first feria (Sunday) it ends on the 2d (Monday); *Suffr*, which comes next, has only 29 days, and therefore begins and ends on the 3d feria (Tuesday); Rabi-el-Avul, having 30 days, begins on the 4th feria (Wednesday) and ends on the 5th (Thursday); and so on of the rest.

Attention to the duration of Zooledgee when the year is intercalary.

The only particular attention required in this process, is to notice whether the year be a common or an intercalary one; because (as has been explained at page 220) in the latter case Zooledgee counting 30 days, ends on the feria next to that on which it began, whereas in common years it ends on the same.

EXAMPLE.

How to find the beginning of every month in the Lunar year.

Let it be required to find the beginning of every month in the year of Hejira 1240.

Referring to the General Table III, where A. H. 1216 stands at top in the margin, with 1240, we find that this year falls in the 19th century, and in the column whose root is 5, which shews that it will begin on a Thursday (Yoom-el-Kamis). The letter B, annexed to its notation, indicates also that it is an intercalary year, consisting of 355 days; and therefore, that the month of Zooledgee counts 30 days.

Again, since the same Table informs us that the proposed year begins on Thursday the 14th August 1824, *Julian style*, if we follow the process indicated at page 223, we find that the Dominical Letters for that *Bissextile* year are FE; and for 1825 D, Julian style, or DC for 1824 and B for 1825 Gregorian style.

With these data we are to proceed as follows:

The character of the proposed year being 5 (Thursday), we turn to the column in Table L, the initial feria of which is 5 at top; and in which we are to continue for the remainder of the year of Hejira 1240.

2. *For the month of Suffr.*

The root of this month, Table L, is 7; i. e. Yoom-el-Eſſabt (Saturday).

To check this, if we count 30 days in the Kalendar from 14th August, we find 13th September; which truly falls on a Saturday.

3. Rabi-el-Avul.

Root 1, i. e. Yoom-el-Ahad, Sunday; count 29 days from 13th September, and we have 12th October, which also falls on a Sunday.

4. Rabi-el-Aukeer.

Root 3, i. e. Yoom-el-Thaleth, Tuesday; count 30 days from 12th October, and we have 11th November, and it also falls on a Tuesday.

5. Giumadi-el-Avul.

Root 4, i. e. Yoom-el-Arban, Wednesday; count 29 days from 11th November, and we have 10th December, Wednesday.

6. Giumadi-el-Aukeer.

Root 6, i. e. Yoom-el-Dgiooma, Friday; count 30 days from 10th December, and observe that the Dominical Letter for 1825 becomes D, Julian style; and we have 9th January 1825, Friday.

7. Regeb.

Root 7, i. e. Yoom-el-Effabt, Saturday; count 29 days from 9th January, and we have February 7th, Saturday.

8. Shababan.

Root 2, i. e. Yoom-el-Thani, Monday; count 30 days from 7th February, and we have 9th March, Monday.

9. Ramazan.

Root 3, i. e. Yoom-el-Thaleth, Tuesday; count 29 days from 9th March, and we have 7th April, Tuesday.

10. Shawal.

Root 5, i. e. Yoom-el-Kamis, Thursday; count 30 days from 7th April, and we have 7th May, Thursday.

11. Zoolcade.

Root 6, i. e. Yoom-el-Dgiooma, Friday; count 29 days from the 7th May, and we have 5th of June, Friday.

12. Zooledgee or Zoolcagiadah.

Root 1, i. e. Yoom-el-Ahad, Sunday; count 30 days from 5th June, and we have 5th July, Sunday.

* * *

If we wish further to check this operation, say,

To the 5th of July add 30 days (because the year of the Hejira 1240 is an intercalary one, and Zooledge has therefore 30 days) and you have 4th August, which by the Julian Kalendar falls on a Tuesday, and therefore 3 should be the character for the ensuing Mahommedan year 1241. Referring to Table I, we find in fact that the said year began on the 4th of August, Julian style, and that it bears 3 for root; therefore, the operation has been well performed.

For having the concurrent beginnings according to the Gregorian Kalendar, the process is exactly the same, excepting that a different Dominical Letter must be used.

Thus employing DC, and B, instead of the former Letters, we shall have,

1	Mahorum A. H. 1240	Yoom-el-Kamis	Thursday	26th August.
2	Suffr	Yoom-el-Eſſabt	Saturday	25th September.
3	Rabi-el-Avul	Yoom-el-Ahad	Sunday	24th October.
4	Rabi-el-Aukeer	Yoom-el-Thaleth	Tuesday	23d November.
5	Giumadi-el-Avul	Yoom-el-Arbaa	Wednesday	22d December.
6	Giumadi-el-Aukeer	Yoom-el-Dgiooma	Friday	21st January.
7	Regeb	Yoom-el-Eſſabt	Saturday	19th February.
8	Shubaban	Yoom-el-Thani	Monday	21st March.
9	Ramazan	Yoom-el-Thaleth	Tuesday	19th April.
10	Shawal	Yoom-el-Kamis	Thursday	19th May.
11	Zoolcade	Yoom-el-Dgiooma	Friday	17th June.
12	Zooledgee	Yoom-el-Ahad	Sunday	17th July.
		and		
	Mahorum A. H. 1241	Yoom-el-Thaleth	Tuesday	16th August.

Thus it was that beginning from the 16th July A. D. 622, of which the corresponding year of the Hejira was 1 *commencing*, and whose root was 6 (Yoom-el-Dgiooma or Friday), the whole of the General Table III was constructed. It is easy to perceive how that Table may be prolonged at pleasure, to any assignable Epoch whatever.

There remains now only to shew, how to deduce any particular date when the commencement of the months and year have been determined.

How to expound any particular date.

This question presents no sort of difficulty; for let Yoom-el-Thani, the 13th of Shawal, A. Hejira 1240, be proposed.

Having found in the preceding article, that the said month will begin on the 19th May N. S. 1824, add 18 days to that date, and you have Monday, the 6th of June at Sun set, Gregorian style.

In the same manner, let the 15th of January 1825 O. S. be proposed, and its concurrent date in the Mahommedan Kalendar be wanted.

Having found in the preceding article, that the 1st Giumadi-el-Aukeer will fall on Friday, the 9th of January O. S. 1825, subtract the same from 15; and the remainder 6, shews that the proposed date will fall on Yoom-el-Kamis, the 6th of Giumadi-el-Aukeer.

Of Table LI, *being the third of this Memoir.*

How to find the Hindu Solar year current on the beginning of any year of the Hejira.

This Table serves to find by approximation the Hindu Solar year current on the beginning of any proposed year of the Hejira, so that their juxta position may always be determined, excepting in a very few cases, which are so clearly indicated that there is no mistaking them (as will be seen hereafter): but to compare any *particular* date, recourse must be had to the means which were disclosed in the Memoir on the Hindu Solar year, because the present Tables give only the commencements of Hindu years concurrent with Christian *Secular* years, which mark the limits of the intermediate years of any century in the scope of three days *Julian* and four days *Gregorian* styles.

The first division of Table LI exhibits the years of the Hejira, with their beginnings according to European expression, concurrent with Christian Secular years from A. D. 622 to 1900.

The second division gives the Hindu Solar years Cali yugam and Saca, with their common beginning, according to European expression, and to the Julian or Gregorian Kalendar, both referred to the same Christian Secular years, which are expressed in the last column on the right.

Now let it be proposed to determine by inspection what Solar year of the Cali yug or Saca, commences or ends in the year of the Hejira 562?

1° Refer to the General Table III in that page which has A. Hejira 495 at top in the margin; you find that 562 falls in the 12th century, on the Christian year 1166 Julian style, and that it begins on the 28th October of that year.

2° To 1166 add 3102; you have 4268 the notation of the year Cali yugam current, and from 4268 subtract 3179, you have 1089 that of the year Saca, or from the birth of Salivahana.

Now reverting to Table LI we find (sec. 2) that the Hindu Solar year concurring with A. D. 1100 began on the 23d of March of that year; and that the Hindu year which concurs with A. D. 1200, began on the 24th of the same month : therefore (preceding article) the year of the Cali yug 4268, concurrent with A. D. 1166, cannot have begun before the 22d, or after the 25th of March of that year; and as the General Table III gave the commencement of the proposed year of the Hejira on the *28th October following*, it is manifest that it fell in A. Cal. 4268, and Saca 1089, and therefore, that these Hindu Solar years commenced in Anno Hejira 561.

In the present case, as the year of the Hejira proposed, began so late in the Christian year as the 28th October, and as the Hindu Solar years from A. D. 0 to 1900 commence somewhere in all the month of March, Julian style, there was no danger of mistaking the notation of the corresponding Solar years of the Cali yug and Saca.

But if instead of A. H. 562, which we have expounded, A. H. 1085 had been proposed, then extracting its notation and beginning according to European expression, out of the General Table III, we find it to concur with A. D. 1674, and to fall on the 28th March, *Julian*, and 7th April, *Gregorian* styles.

Now Table LI shews that the Solar Hindu year which concurs with A. D. 1600, began on the 27th March, *Julian*, and 6th April, *Gregorian* styles. And that the Hindu year concurrent with A. D. 1700 began on the 28th March O. S. and 8th April N. S. Therefore, the Hindu year may have commenced either on the same day, or two days before, or two days after the proposed year of the Hejira; so that its notation, viz. whether it should be 4817 or 4816 Cali yugam, remains

An irreducible case by the Table.

doubtful. This case is therefore irresoluble by the present Tables alone, and recourse must be had to the Hindu rule for determining the beginning of the particular Solar year proposed.

But these occasions are so rare, that between A. D. 1500 and 1900 they occur only four times, and in order to render every resolution possible by help of the present paper, I have calculated the commencement of the Solar years of the Cali yug 4711, 4776, 4841 and 4906, on which the irresoluble case recurs, which, according to European expression, are as follows:

Hindu years.		Christian years.	Years of the Hejira.			Beginning of concurrent Hindu Solar years.	
Caliyug.	Saca.		Old Style.		New Style.	O. S.	N. S.
4711	1532	1609	1018	27th March	6th April	28th March	7th April
4776	1597	1674	1055	25th March	7th April	29th March	8th April
4841	1668	1739	1152	30th March	10th April	29th March	9th April
4906	1727	1804	1219	31st March	12th April	29th March	10th April

It will easily be concluded from this Table, that the 1st Chaitram A. Cali yug 4711, falls on the 2d Mahorum A. Hejira 1018.

1st Chaitram A. Cali yug 4776—2d Mahorum A. Hejira 1055.

1st Chaitram A. Cali yug 4841—29th Zooledgee A. Hejira 1151.

1st Chaitram A. Cali yug 4906—28th Zooledgee A. Hejira 1218.

Given the years of the Cali yug or Saca, how to find that of the Hejira,

The converse of this proposition is still of easier solution; for suppose that the year of the Cali yug 4940, or 1761 Saca, be proposed, and that it was found to begin on the 11th April A. D. 1838 N. S.

Then referring to the General Table III we find at once that its commencement fell on A. Hejira 1254, the beginning of which occurred on the 27th March N. S. But as that Mahomedan year lasts only until the 11th April following, it is manifest that the commencement of A. Hejira 1255 will also fall in the same year Cali yugam 4940; but that from the 6th Mahorum the year of the Hejira 1255 will concur with A. Cali yug 4941, and Saca 1762.

It will be observed, that the irreducible case adverted to in the preceding article, does not exist on this side of the question; for as the feria beginning the Hindu Solar year, and its date according to European expression, are supposed to be given by the proposition, the General Table III shows at once whether that date falls before, or after the commencement of the concurrent year of the Hejira.

⁂

NOTE I.

On the juxta position of the beginnings of the Mahommedan Lunar and Hindu Luni-solar years.

Mahommedan and Hindu Luni-solar periods compared.

If the *Chandra mana* had not been subjected to intercalations which have no analogy to those which are used in the Arabian Kalendar, there would have been no difficulty in comparing dates proposed in these two accounts of time, the difference of their periods being so very trifling, that for a great number of years it might have been neglected without inconveniency. Here follows a comparative view of the respective Lunar years and months on which the operation would depend.

	Hindu time of 60 gaddias to a day.					European time in hours.				
	D.	G.	V.	P.	S.	D.	H.	'	"	‴
Hindu Lunar year (Surriah Siddhanta)	354	22	1	23	57	354	8	48	33	34,8
Arabic - - -	354	22	1	30	0	354	8	48	36	0,0
Difference, Arabic		+		6	3				2	25,2
Hindu Lunar month do. -	29	31	50	6	59	29	12	44	2	47,6
Arabic - - -	29	31	50	7	30	29	12	44	3	0,0
Difference, Arabic		+			31					12,4
Thus whilst the Arabian Synodical Cycle of 30 years consists of (*)						10631	0	18	0	0
The same number of Hindu Lunar years is - -						10631	0	16	47	24
The difference being in 30 years - -								1	12	36

The beginnings of the Mahommedan and Hindu Luni-solar months may be compared without any reference to names.

But although the Hindus really add or retrench nothing in their computations of Astronomical periods, yet as the construction of their Civil Kalendar requires every two or three years the intercalation of the *name* of a month, whilst time follows its regular course, and as the Arabs only intercalate days, all that can be done is, after computation of the same, to compare the *Prathama Tidhis* which begin each Lunar month and year, with the dates of the Civil beginnings of some Mahommedan month which fall nearest to them and which never differs more than a couple of days therefrom, but which will not recur as to *names* in a similar series, for reasons which it is unnecessary to repeat in this Memoir.

(*) The Civil Arabic Cycle is thus constructed.

19 years of 354 days - - -	6726d
11 years of 355 days - - -	3905
Number of complete days -	10631

As for referring the Hindu Tidhis, or Luni-solar days of the Hindu year, to those of the Mahommedan Kalendar, it would be vain to attempt it by any mechanical process; a Tidhi being the space of time which is requisite for the Moon to move through 12° of her path, to or from the Sun, and consequently beginning at no fixed instant of the day or night.

Computation of the conjunction which preceded the beginning of the Æra of Hejira, by the Vakiam, or Solar process.

Computation of the juxta position of the beginning of the first year of the Hejira, and of the month Bhadrapada of the Luni-solar year 3724 of the Cali yug.

We have seen at Example V, page 38, of the Key to the Madhyama Saura mana, that the first Civil day of the Hejira, according to vulgar account, viz. 16th July A. D. 622, fell on Friday the 26th Audi of the 3724th year of the Cali yug: but that Hindu Solar date was deduced from the European one, and not computed on the principles of Indian Astronomy, which we shall do in the present Note; and as independently of its peculiar interest, it presents a case where the Ahargana is less than a *Vedam* or 1600984 days, (hitherto not considered), I shall insert it at full length for the reader's information. The computation will be referred to the supposed Meridian of Trivallore.

The Aharganas resolved in the usual manner, or by Tables XLVIII and XLIX, will be

	Solar. D.	G.	V.	P.		Lunar. D.	G.	V.	P.
1st Chaitram 3724 - - -	1359855	55	12	30	30th Phalguna 3723 -	1359854	2	41	51
add 3 Solar months, Tab. XLVIII,	93	56	22	3	add 4 Lunations, Tab. XLIX,	118	7	20	12
1st Audi - - -	1359949	51	34	33		1359972[	10	2	3
	+ 24					+ 1			
25th Audi commencing	1359973	51	34	33	Lunar Ahargana -	1359973			
		60			Solar Ahargana -	1359949			
or 24th when the time wanting of Sun rise was - -		8	25	27		24			

Dividing the respective Aharganas by 7, the Soota dinas will be, *The Sun, Thursday; The Moon, Wednesday;* and the Dominical Letter being expounded by Tables V and VI, is C, giving Wednesday the 14th and Thursday the 15th July 622.

For finding the Moon's place we are therefore to compute her *Druva, Chandra Vakiam, Dhurmavanham,* and *P'hala,* by her Ahargana above found, which being only 1359973, shews that it bears not division by a *Vedam.*

		n.
Vedam	1600984)1359973(	0
Raz. Gherica	12372)1359973(	109
	12372	
	122773	
	111348	
Calanilam	3031)11425(	3
	9093	
Devaram	243)2332(	9
	2232	
Chandra Vakiam	100	

	s	°	′	″		s	°	′	″
109 ×	3	27	48	10	- -	2	0	30	10
8 ×	11	7	31	3	- -	9	22	33	9
9 ×	0	27	44	6	- -	8	9	36	54
						8	2	40	13
Equation of Vakiam 100, Table XXVI,						8	1	17	0
☽'s place uncorrected - - -						4	3	57	13

In order to find the Moon's *true* place, compute that of the Sun at his rising on the same day, 25th Audi commencing:

On the 1st Audi the Sun entered the Sign Carcata ♋ the 4th of the Zodiac. He had therefore completed - - - - - - 3^{s} 0° 0′ 0″

To which add for 24 days, - - - - - - + 24 0 0

And as on his entrance into the new Sign there wanted of Sun rising 8^{g} 25^{v} 27^{p}, add the guddias as calas and viguddias as vicalas - + 8 25

☉'s Saura place on the 25th at Sun rise - - 3 24 8 25

And his Equation by the Yoghiadi Table (XXVII, part 1) being — (22′ + 23′ + 24′) for 24 days complete, and 22″ for 8^{g} 25^{v}, we have 1° 9′ + 22″, which subtract - - - - - — 1 9 22

☉'s Sputa Graha or true place, 25th Audi - 3 22 59 3

For the Moon's place corrected.

Having found the Sun's *true* place, we may now correct that of the Moon, as follows:

	s.	°	′	″
☽'s place uncorrected - - - - - -	4	3	57	13

By Table XLVII, we find the *Desentara calas* for the preceding month Auni ♊ - - - - - - + 7 0

For the andra vicalas (same Table) we find + 2, and the odd degrees, minutes and seconds of the ☉'s apparent Longitude being 22° 59′ 3″

Multiply by - - - × 2

The 1st Equation will be - - - 45″ 58‴ 6⁗ or say + 46

For the 2d Equation. As the Moon is more advanced than the Sun, from Table XXVI take her true motion for Chandra Vakiam 100, 844′

And her mean motion being - - - 791

Difference - 53

Now after division of the Ahargana by the three last Elements there were, among the rest, 9 Devarams, to each of which are due 32‴, which gives 9×32‴=4″ 48‴, to which multiplying by the difference 53′ gives 4′ 14″ 24‴, which because the ☽'s *true* is greater than *her* mean motion, add + 4 14

☽'s Sputa Graha, or apparent place, 25th Audi at Sun rise - - 4 4 9 13

☉'s do. - - do. present page - - - 3 22 59 25

☉ and ☽'s apparent distance at do. - - 11 9 48

For the Sun's true motion.

By the Yoghiadi Table (XXVII, part 1) the Equation of the Sun's motion for 8 days *to come* on the 24th Audi complete, is —22′ = therefore for that day it is $\frac{-22'}{8} = -2'\ 45''$

Which subtracted from - - - 60

Gives the ☉'s Sputa Gati, or true motion sought - 57 15

For the relative motion.

☽'s Sputa Gati - - - - 844′ 0″
☉'s do. do. - - - - 57 15

Relative motion - - - - 786 15 - 13° 6′ 45″

For time due to distance.

13° 6′ 45″ : 60^{g} (one day) :: 11° 9′ 48″ : $51^{g}\ 4^{v}\ 51^{v}$.

And because at the time of Sun rising on the 25th Audi, the Moon's apparent Longitude, was greater than that of the Sun, it shews that the conjunction was past, therefore subtracting the quantity above elicited from - - - - $60^{g}\ 0^{v}\ 0^{v}$
51 4 51

We have the true time of conjunction, 24th Audi 3724 - 8 55 9

The preceding result (though only an approximation) is perfectly sufficient for our present purposes, and shews that according to the Rules of Indian Astronomy, the conjunction which preceded the 1st Civil day of the Hejira fell some time in the morning of the 24th Audi A. Cal. 3724, and therefore the *Prathama* Tidhi of the Lunar month *Bhâdrapada*, on the 25th, answering to Thursday the 15th July A. D. 622, which is precisely the day referred to by most Arabian Astronomers as that which begins the Hejira.

This coincidence may give rise to some speculations respecting the authority which was originally consulted when the Epoch of the *Flight* was determined. For at the time when the prophet unfurled the standard of the faith, the Arabs had certainly no Astronomy of their own, and probably none at all of others; and although he may have resolved on assuming the day of his exile for the first of his new æra, the task of fixing it permanently must have devolved on his successors.

But the Alexandrian School and Library, were destroyed on the 2d *Muharum* of the 21st year of the Hejira, a time too near the beginning of the revolution to suppose that it may have been previously consulted on the construction of a new Kalendar. It is therefore more probable, that when in more settled times, Mahommed's successors resolved on that measure, they may have had recourse to their Indian neighbours, who since the destruction of the Alexandrian School were the only nation in the East who cultivated the sciences.

⁂

NOTE II.

On Dr. Hutton's Rule for finding the year of the Hejira.

It is difficult to understand on what principles Dr. Hutton has established the Rule which he gives in his Mathematical Dictionary for finding the Christian year concurring with any proposed year of the Hejira: it runs as follows:

> " Reduce the given years of the Hejira into days by multiplying by 354, divide the product
> " by $365\frac{1}{4}$ and to the quotient add 622 years of the Hejira commenced."

[Mathem. Dictio. Vol. I, page 593.

I fear that this rule is more remarkable for its brevity than for its accuracy (for the above passage contains the whole of the Rule). If it were sufficient to multiply the proposed years of the Hejira by 354 for obtaining the sum of days elapsed since its Epoch, what becomes, it may be asked, of the eleven intercalated days in the Cycle of 30 years, which make the years on which they fall be of 355 days, and in the course of 90 years retard the beginning of the Civil year by 33 days?—Let us try the merits of this rule by its results.

Let it be proposed to find the Christian year concurring with A. Hejira 1215.

We have $1215 \times 354 = 430110$; and $\frac{430110}{365\frac{1}{4}} = 1177, + \frac{210,75}{365,25,}$ and lastly $1177 + 622 = 1799$. So that following the letter of the precept A. H. 1215 would concur with A. D. 1799, which however, throughout Christendom and Islaamism is taken to be 1800: the 210 days which remain after division by $365\frac{1}{4}$ are insufficient to account for such a difference, although they would bring the epoch of coincidence about 7 months later ($206^d\ 17^h\ 8'\ 31''$ being equal to that number of Lunar months), but these odd days *end* at no definite period; and no notice is taken of them in the precept: We are therefore compelled to conclude, that the very learned and justly celebrated author has only glanced at a subject which it did not enter into his views to investigate minutely, as may be inferred from the shortness of an article which, though intimately connected with Astronomy, was disposed of in twelve lines of his Dictionary.

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POSTSCRIPT.

Some time after the Kala Sankalita was committed to the press, Mr. Bentley's posthumous work, entitled "An Historical View of the Hindu Astronomy from the earliest dawn of that "science, down to the present times" came to my hands, having just appeared for the first time in Madras, though published in Calcutta two years before.

On a cursory perusal of that production, (which remained only a few days in my possession, and at a time when I was engaged in editing the present work), I congratulated myself on having pursued an object totally different from that which Mr. Bentley had in view: For it was then too late to have benefited by his instruction; and in case of collision, with such unequal means and powers, I would have had cause to apprehend the judgment of the public on the issue.

Fortunately for me, Bentley soared to the highest regions of investigation, whilst I was collecting tools for labour, and toiling in the lower walks of research. He strove to drive error from the seat of truth, whilst I was employed in shewing how she ruled the population of the East, during many centuries of usurpation; in fine, his object was philosophic, and mine merely one of practical expediency. Our works may therefore (with an inverse degree of applause and censure) subsist together, and prove useful in their respective departments.

It will be observed that the abolition of Sydereal Astronomy pronounced by the work alluded to, to have taken place from the VIth century upwards, renders a great part of my speculations unavailing; to which I shall reply that, although agreeing in substance to a doctrine which the scholiast has so ably supported, yet I do not go with him the whole length of believing that the use of Ancient or Tropical Astronomy, was so suddenly relinquished, and the Sydereal so readily adopted, as might be inferred from the *precise Epoch* which he assigns to that event (March A. D. 538, page 73). It required nearly two centuries to drive the Aristotelean philosophy out of the Universities of Europe, and arguing from analogy, it is not to be supposed that a people, of all others the most attached to its institutions, would have simultaneously adopted new theories, when the old ones were still found to answer, (and were in reality better than the new), for no other purpose than "to appear the most ancient nation in the universe (70);" for, although I do not pretend to say that Mr. Bentley meant to convey absolutely such a notion, yet his text bears that construction.

Before the Epoch referred to, the Sydereal Astronomy (certainly the most commodious of the two) must surely have thrown out some roots in the minds of the learned men of those times, and have lurked, perhaps during several centuries in the public opinion. Some sect of philosophers must have taught it; and some separate tribe or nation must have counted time by the same, before it became the general doctrine of India. And from the same considerations it may be believed that Ancient Astronomy has left shoots which it must have taken time to extirpate. Nor can I believe that the Braminical power, (which rests entirely on opinion, great as it now is, and has been) can have proved so efficient as to have occasioned the sudden and total overthrow of the latter, in the same manner as Timur Long, and Nadir Shaw subsequently annihilated their public institutions. It is therefore highly probable, that Sydereal Astronomy began to be in repute, some hundreds of years before it openly superseded the Tropical one; and as to the motive of its abolition, I cannot be persuaded that the specific purpose of any set of men, when effecting a change can have been *to do away their Ancient History* (page 70).

Some old documents (and particularly inscriptions) may therefore still be found bearing dates in *Sydereal account*, more ancient than the Epoch assigned to its legal admission, and to these my Tables will apply. I beg it, however, to be understood, that I intend no review of Mr. Bentley's valuable production, for which I have neither leisure, means, nor abilities; most of his conclusions appear to me decisive, and, more than all the rest, those which attack the unfathomable antiquities of the Hindus. But I did not wait for the appearance of the "*Historical View*" to decide against them; for although unacquainted with Bentley's discoveries, I have long since been persuaded, and have declared it to be my opinion, that their periods and yugs were nothing else but mathematical contrivances, resting at one end on observations taken at the time when they were invented; and at the other, on some Epoch so very remote, that the greatest possible error in the position of the Planets at the time referred to (which could never exceed 6 signs in Longitude) must become almost insensible in their annual revolutions, and unimportant until after a great number of years intervene, either before or after the time of invention.

There is something so obvious in this view of the subject, that it cannot be wondered at, if Bentley fancied (though erroneously) that the attacks made on his doctrines were designed for him, personally. Another motive, perhaps equally reprehensible, was I fear, the hidden cause of their having been so frequent and repeated. In France I can affirm, on the *verbal* and *written* assurance of the late M. *Delambre*, that Bailly's doctrines never obtained any proselytes among men of real science; and when on a particular occasion the celebrated *La Place* asked me (*) whether we Indian Gentlemen, and Members of the Asiatic Society, believed that any of the Indian periods were established on actual observations, on my assuring him of the contrary he expressed much satisfaction, and replied that he was sure such a notion could never have been long entertained by any *Savant*.

But I fear the author of the "*Historical View*" more justly ascribed the perseverance of some of his critics, to a bent towards infidelity, which in some instances was hardly denied; such was the prevalent philosophy at the close of the XVIIIth century. But as *scepticism* has now

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(*) At a meeting of the Board of Longitude in April 1816.

succeeded to incredulity, and as the ruling maxim of the beginning of the XIXth, is that *any thing may be true,* I have no doubt that the doctrines contained in that *most profound* work that has hitherto appeared on Hindu Astronomy, will meet with little or no opposition from any quarter; at least from such as the author need have cared for if he had lived to enjoy the success which I anticipate.

Whatever be the final opinion of the scientific world on the antiquity of Sydereal Astronomy, and the manner I have applied it to the construction of the Hindu Kalendars (which was the only province I was desired to investigate), I commit the present work to the judgment of the public with no sanguine expectation of success; but with a sincere desire that it may, (in its measure) prove useful to Chronology. Should I be disappointed in that expectation, I shall be consoled by the recollection of the amusement it has procured me during several years; and the opinion it has enabled me to form of the skill and ingenuity of the Natives of India, which, though duly appreciated by many of their rulers, is not sufficiently known to the great mass of Europeans who live among them.

END OF THE FOURTH MEMOIR.

APPENDICES.

APPENDIX I.

On the manner of computing the Ahargana *for the beginning of the Solar years, and end of the Luni-solar years, counted from the commencement of the Cali yug, by means of the Tables, from which the* Strostidi digona *and* Soota dina *for either may easily be deduced.*

All the Rules given in Hindu books for the resolution of the *Ahargana*, are very operose, and consequently liable to mistakes in the computation. It will be found, however, that in the Indian process, that Element is unnecessarily wrapped up in mystery; and that both the Solar and Luni-solar Aharganas may be obtained with perfect accuracy, by help of Tables which are neither difficult to use, nor to understand.

I shall first consider the Solar Table XLVIII, which is divided into two parts, the first giving the Ahargana according to the *Surriah*, and the second to the *Aria* Siddhantas.

Table XLVIII, part 1.

According to the former Sastra, the duration of the diurnal revolutions of the Stars in one year is $\frac{1582237828}{4320000} = 366^d, 15^g\ 31^v\ 31^p\ 24^s$ and 1582237828 — 4320000, is the number of Bhumi savan (natural) days in a Maha yug: hence the Solar Sydereal year, according to the Surriah Siddhanta is $\frac{1577917828}{4320000} = 365^d\ 15^g\ 31^v\ 31^p\ 24^s$, and this quantity is the constant ratio of the first part of the Table.

Number of diurnal revolutions of the Stars in one year.

Solar Sydereal year Surriah Siddhanta.

In the same manner the diurnal revolutions of the Stars in one year according to the Aria Siddhanta is $\frac{1582237500}{4320000} = 366^d\ 15^g\ 31^v\ 15^p$; and 1582237500 — 4320000 = 1577917500^d, is the number of Bhumi savan days in a Maha yug; consequently the Solar Sydereal year is $\frac{1577917500}{4320000} = 365^d\ 15^g\ 31^v\ 15^p$, which is the constant ratio of the second part.

Do. Aria Siddhanta.

Lastly, we have shewn at page 12, 1st Memoir, that because the year which opened the Cali yug began $4^d\ 51^g\ 8^v\ 45^p$ from the commencement of an entire week, the Hindus, with a view to reckon from a complete period, added a *Cshepa* of $2^d\ 8^g\ 51^v\ 15^p$ (complement to 7 days) to the Ahargana, which was the same thing as retrenching it from the Epoch itself.

It is therefore always to be remembered, that with respect to the true Epoch of the Cali yug, there will be found that difference in the Tabular results.

For let the Christian date of the Yugadia, or first day of the Cali yug, be sought; proceeding as shewn at Example 5, page 26, with Table VI, and at the Example in page 30, with Table VIII, we shall find

Cshepa or Equation to a complete week.

	D.	G.	V.	P.
Initial Root A. A. C. 3101 - - - -	(2)	51	8	45
Add Cshepa - - - -	(2)	8	51	15
Root sought - - - -	(5)	0	0	0
	Friday.			

Date of the Cali yugadia 18th February A. A. C. 3101.

By the Tables 16th February.

And as the Dominical Letter for that year will be found to be B, the Yugadia under consideration falls on the 18th February of the year before Christ 3101 *current*, whereas the Hindu Tabular date, gives only the 16th.

As the Hindu Tables for finding the time of the *Sun* returning to the beginning of the Solar Zodiac, are affected by this Equation, it must be accounted for when calculating the Solar Ahargana; observing that, if computing *from* the Epoch the *Cshepa* becomes a *Sodhyam* or constant Equation to be subtracted from the aggregate sum of days, guddies, &c. reckoned from the assumed Epoch as given in the Table.

The preceding considerations will suffice for explaining the construction of the first and second parts of Table XLVIII; we shall now give some Examples of their use.

Example I.

Example 1, 1st part of Table XLVIII.

1º Wanted the Solar Ahargana for the beginning of the Solar year 4924 of the Cali yug, or 4923 complete, answering to A. D. 1822, according to the Surriah Siddhanta.

	Y.	D.	G.	V.	P.	
By Table XLVIII, part 1, we have for	4000 -	1461035	1	33	20	
	900 -	328732	52	51	0	
	20 -	7305	10	30	28	
	3 -	1095	46	31	34	12
		1798168	51	29	22	12
Subtract Sodhyam		— 2	8	51	15	0
1st *Mesha masha* ♈, or modern *Vaisácha*; and Tamul *Chaitram*, Ahargana sought - -		1798166	42	38	7	12

And for the Soota dina 7)1798166ᵈ(256S8

with a remainder of 6 which counted from *Friday*, shews that the *Soota dina* or initial feria falls on *Thursday*.

2º Wanted the Ahargana for the 1st of the Solar mouth *Vrischica masha* ♏; the modern *Márgesiras*; and of the Tamul denomination, *Cartiga*.

	D.	G.	V.	P.	S.
Ahargana, 1st Vaisácha, above found - -	1798166	42	38	7	12
Add collective number of days registered in the last column down to Cartiga - -	216	48	13	18	39
Ahargana, 1st Margasiras; which divide by 7)1798383	(30	51		25	51

remainder 6 and counted as usual fro Friday, gives the Soota dina on *Thursday*.

There being not the least difference from what precedes in the manner of using the second part of Table XLVIII, and all cases, either according to the Surriah or Aria Siddhantas, being to be resolved precisely in the same manner, I shall dispense with giving any more Examples for the Solar Ahargana.

To find the Luni-solar Ahargana by means of Table XLIX.

For the Luni-solar Ahargana, Table XLIX.

The construction of both parts of this Table, is as simple as that of the preceding one. Its whole theory rests on what follows.

First part.

According to the Surriah Siddhanta, there are 57753336 periodical revolutions of the Moon in a Maha yug or 1577917828 natural days. Hence the Moon's periodical month is $\frac{1577917828}{57753336}$, or $27^{d}\ 20^{g}\ 20^{v}\ 21^{p}\ 39^{s},77$, &c. ($27^{d}\ 8^{h}\ 8'\ 8''\ 39''',6$ European time.) From the number of periodical revolutions in a Maha yug, subtract the number of Solar days in that period, or 57753336 — 4320000, you have the number of Synodical revolutions in the same time, = 53433336; and $\frac{1577917828}{53433336}$ or $29^{d}\ 31^{g}\ 50^{v}\ 6^{p}\ 59^{s},78$ ($29^{d}\ 12^{h}\ 44'\ 2''\ 47''',6$ European time) is the duration of a mean Lunation, according to the Surriah Siddhanta: a mean Lunar year of 12 months is therefore equal to $354^{d}\ 22^{g}\ 1^{v}\ 23^{p}\ 57^{s},14$ ($354^{d}\ 8^{h}\ 48'\ 33''\ 48'''$ European time) which is the constant ratio of the first part of Table XLIX.

Second part.

That of the second part is deduced from the same principles, the only difference being that the Aria Siddhanta counts only 15779175200 natural days in a Maha yug. According to that authority the Moon's periodical month is therefore $27^{d}\ 19^{g}\ 17^{v}\ 58^{p}\ 29^{s}$ &c.; the Synodical $29^{d}\ 31^{g}\ 50^{v}\ 5^{p}\ 40^{s},21$, and the Lunar year of 12 months $354^{d}\ 22^{g}\ 1^{v}\ 8^{p}\ 2^{s},6$ which is the constant ratio of the said second part.

Considering how very intricate the process is for finding the *Adigah* months and *Cshaya Tidhis* by the Sastra rule (*), I originally concluded that there could be no simpler means for finding the Luni-solar Ahargana, and when from stress of labour I endeavoured to free myself by means of Tables, from those perpetual rules of three which it imposes, a typographical error in Mr. Davis' paper on the Astronomical computations of the Hindus (†), making the Lunar Synodical month $29^{d}\ 31^{g}\ 50^{v},6$ instead of $29^{d}\ 31^{g}\ 50^{v}\ 6^{p}$ &c. for a long time defeated my endeavours. But when once I had discovered the *erratum*, there was no further difficulty in constructing my Table, which I subjected to the following test.

Epochs of intercalations by the Tables.

We have seen in the article of *mean intercalations*, Part III, Article 1 of the second Memoir, that the period of recurrence of an *Adigah* month was $2^{y}\ 8^{m}\ 16^{d}\ 3^{g}\ 55^{v}$ &c. and I resolved the same by means of the first part of Table XLIX, as follows:

(*) Vide Key to the Siddhanta Chandra Mana, Part II, Article I.

(†) Asiatic Researches, vol. II, page 232, English Edition, which teems with errata of the most fatal kind to the true exposition, and acquisition of the first notions of Hindu Astronomy, from that otherwise, elegant production.

	D.	G.	V.	P.	S.
The mean Solar Syderial year being -	365	15	31	31	24
And the Lunar year of 12 months -	354	22	1	23	57,14
The annual difference is - -	10	53	30	7	26,86
So that for one month of 30 days the Equation is		51	27	30	37,23
And for one day of 60 guddias - -		1	43	55	1,273

If with these quantities we expound the period of intercalation referred to, we shall find

	D.	G.	V.	P.	S.
For 2 years -	21	47	0	11	53,72
,, 8 months -	7	15	40	1	57,84
,, 16 days - -		29	2	40	20,07
	29	31	42	57	11,63
Which subtract from 1 mean Lunation -	29	31	50	6	59,78
Difference -			7	9	48,15

The same by the Hindu rule.

and for the time due to this difference say, as 1ᵛ 48ᵛ,91 (the Equation for one day), to 3600 (the number of viguddias in a day of 60 guddias); so 7ᵛ,15 &c. (the difference to a mean Synodical month), to 3ᵍ 55ᵛ,8 &c. which, with the above quantities, gives *the time due to the intercalation of one mean Lunar month*, 2y 8m 16d 3g 55v,8 &c. very nearly the same as was found by the Hindu rule referred to.

Having premised thus much, I shall give the following Precept and Example.

PRECEPT.

Find the Solar Ahargana of the proposed Luni-solar year for an Index.

1º Find the Solar Ahargana for the proposed year of the Cali yug, which will serve as an *Index for finding the Luni-solar one.*

2º Take out of the two first columns of Table XLIX, part 1, the quantities answering to as many Lunar years of 12 months as there are Solar ones proposed, and add them together: the rest of the operation will serve to find the intercalations.

Manner of using the Table.

3º Subtract the sum of days, &c. so obtained (neglecting the fraction) from the sum of days of the Solar Ahargana, and take out of Table XLIX the quantity nearest to the remainder, which write both under the Lunar sum and the remainder of the Solar Ahargana, of which take again the difference; follow the same process as before until the last remainder under the Solar Ahargana be less than a mean Lunation, which in that case neglect.

4º Cast up all the Lunar periods so obtained, and the sum will be the Luni-solar Ahargana sought.

N. B.—This process has the advantage that in no case whatever the Luni-solar, can exceed the Solar *Ahargana*, which is not the case in the Sastra rule, and that it shews at once the number of intercalary months which have been introduced in any proposed interval. The Precept applies equally to part 1 and 2 of Table XLIX.

Example II.

Wanted the Luni-solar Ahargana for the end of the year of the Culi yug 4923, by part 1.

Rule,

Sum of days in the Solar Ahargana found by Table XLVIII - 1798166
(1) - 1744549
53617
(2) - 35436
18181
(3) - 17718
463
(4) - 354
109
(5) - 88
Neglect remainder 21

	Y.	D.	G.	V.	P.	S.
Table XLIX, part 1, column 2 -	4000 -	1417468	13	16	49	20
	900 -	318930	20	59	17	6
	20 -	7087	20	27	59	2,8
	3 -	1063	6	4	11	51,42
	(1)	1744549	0	48	17	20,22
Intercalations.	100 (2)	35436	42	19	55	14
	50 (3)	17718	21	9	57	37
	1 (4)	354	22	1	23	57,14
3 Lunar months (5)		88	35	30	20	59,34
Ahargana sought		1798147	1	49	55	7,70
By the Tellinga rule		1798147	1	50	32	0
Difference		-	-		36	52,3

But as the day current is wanted, and as 1g 49v 55p have already expired of it,

To 1798147
Add 1

Ahargana to be used 7)1798148(256878
Remainder 2 i. e. *Saturday* the Soota dina;

and as this Element is only used to the nearest day, the difference of 36,5 paras, from whatever it proceeds, is of no sort of importance.

For the Strostidi digona.

As 151 Lunar years and 3 months have been intercalated for bringing the Luni-solar to the nearest possible time of the Solar Ahargana, it follows that in 4923 Solar Sydereal years (account of the Surriah Siddhanta) there have been 1815 Luni-solar months intercalated.

Lastly, if to the constant number - - - 714402296627 days
We add Ahargana - - - - - 1798148
We have the Strostidi digona for A. C. 4923 - 714404094775

as accurately as if it had been computed by the process explained in the 1st Article of the 2d Part of the *Key to the Siddhanta Chandra Mana.*

2d part of Table XLIX.

The rule by the second part of Table XLIX being precisely the same as the preceding one, *mutatis mutandis*, no Example is necessary; I shall only state that the Ahargana according to the quantities used in the Aria Siddhanta for the same year is

D.	G.	V.	P.	S.
1798146	39	24	28	53,0

And consequently for the current day - - - + 1
And for the Soota dina - - - - 7)1798147(256878
remainder 1 which counted

from Thursday, gives *Friday* for the Soota dina.

Difference of Luni-solar Aharganas by the Surriah and Aria Siddhantas.

Here it may be observed that according to the Surriah Siddhanta,	D.	G.	V.	P.	S.
the Ahargana was - - - - -	1798147	1	49	55	7.7
And by the Aria Siddhanta - - - -	1798146	39	24	28	53,0
Difference		22	25	26	14,7

Of no consequence.

So that although by the *Soota dina*, there seems to be one day of difference for the conjunction, yet there is in fact only $22^g\ 25^r\ 26^p\ 14^s,7$ disagreement between the two accounts, which difference is of no sort of importance, because in the computation of the Tidhis, the Sun and Moon's *real* positions in Longitude at mean midnight at Lanca, and not the time wrought by the rule, are what determine the beginning of the Lunar month, which will find its true place whether we use *Friday* or *Saturday* as the day to work for.

Generally the Southern Astronomers, though working in Solar time, prefer making use of the Lunar Ahargana of the Surriah Siddhanta.

Case where the Luni-solar is greater than the Solar Ahargana.

An intercalary month to be retrenched when using the Sastra rule.

Not to be cared for when using the Tables.

It sometimes, though rarely, happens that on certain years (as will be the case at the end of the 4951st year of the Cali yug, answering to A. D. 1850) on computing the two *Ahargunas* by the Sastra rules, the *Luni-solar* will be found *greater* than the *Solar* one; which would seem to indicate that the Chandra Mana begins, *after* the Solar year: but in such an occurrence the rule directs that an intercalary month be retrenched, from both Ahargunas, and thus the antecedent conjunction determines the beginning of the new Astronomical year. This of course disturbs temporarily the order of the intercalations; and is the cause why the original series in the Cycle of 19 years undergoes a change in its disposition (*): but the only consequence in the Kalendar is, that as the year on which the case occurs would have been *embolismic*, it becomes a common one, and that the following one from *common* that it would have been, becomes an intercalary one. On working the two Ahargunas by the Tables XLVIII and XLIX, there can be no fear of a mistake respecting the true commencement of the *Chandra Mana* arising from the above cause; because by the Precept, the Lunar is unavoidably kept below the Solar Ahargana.

(*) Vide page 60.

END OF APPENDIX I.

APPENDIX II.

Object of Appendix II.

Describing a particular method for expounding dates found in old Inscriptions, the only vestiges of which consist of the recorded years expired since the beginning of the Cali yug, from the birth of Salivahana or of the Cycle of 60 years, and of the Sun's apparent place in the Hindu Sydereal Zodiac at the time of the commemorated event, and also, for referring the Epochs of ancient phænomena recorded in European time, to their corresponding Hindu Solar dates.

To refer the Sun's mean place in the Indian Sydereal Ecliptic, to his mean place at the same instant in the European Tropical Ecliptic, by one single operation.

The questions under consideration are to be resolved by means of certain formulæ which enable the computer to refer the Sun's mean place in the Indian Sydereal Ecliptic, as deduced from the time assigned to his entering any of its Signs in the Solar Kalendar, to his mean place in the *European* Tropical Ecliptic, at the same instant of time, by one single operation; thus affording means for correcting the Hindu Solar Tables, and also those of the Planets, as far as the computation of their position depends on the Sun's place and the beginning of the Sydereal Zodiac, the duration of the Solar year being $365^d\ 15^g\ 31^v\ 15^p$.

The present Hindu system of Astronomy supposed permanent.

Not so in reality.

I have stated in the Preface of this work (page iv), that my intention was to expound the operations of the system now generally in use in these parts of India, as if it had been followed during all past ages, and were to continue to be so to the end of time; and in the present tract my purpose remains unaltered, although I profess to be one among those who have no faith in that proposition. Any person who has looked into books of Hindu Astronomy knows, that in remote times the Solar year was made to begin successively with the months Aswina (now the 6th of the year), Cartica, Margasiras (*), Paushia, Magha, Phalguna, Chaitra, and lastly Vaisácha (†); the line of the *Ricshas* or *Rishis* (‡) intersecting at the corresponding times the first points of

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(*) The name of which was changed into that of Agrahayan on that occasion.

(†) In the present paper I shall use the Bengal denomination of the Solar months in preference to that of the Tamul, being more generally known; though, from the Bengal names being the same as those of the Lunar months, the latter be less convenient, because less distinct.

(‡) The line of the Ricshas, as called in Tellingana, and Rishis in Bengal, is a great circle passing through the Pole of the Ecliptic, cutting a certain Star in the Constellation of the Great Bear, called *Maha Ricsha*, supposed by some to be β, by others to be γ or δ Ursæ Majoris, and meeting the Hindu Yoga Star *Vaidhriti*, believed to be the same as ζ Piscium, although no great circle passing through the Pole of the Ecliptic could be made to intersect with any precision, any three of these points.

the Lunar mansions *Chitra*, *Vaisac'ha*, *Jyésh'ha*, *Purva A'shád'há*, *Srávana*, *Satabhisha*, *Uttara Bhádrapada*, and lastly *A'swini*, which according to present theories, marks the beginning of the fixed Lunar and Solar Zodiacs.

Epochs of the various beginnings of the Hindu Solar year the subject of much discussion.

At what precise Epochs these changes have been effected is a question which, for the last five and twenty years, has divided those of our European cotemporaries who have cultivated Hindu Astronomy; and as the succession of these changes must have depended on the precessional variation, the motion of the Equinoctial points has given rise to discussions which would have been rendered still more animated, if the Native Sastras had been called upon to take a part in them. With these changes, and their Epochs, I shall have nothing to do. The labour of a man's whole life would probably not suffice to pass a competent decision on such divergent opinions, and no time would remain to apply a final resolution to any useful purpose. It suffices to mine to know, that the most averse to the antiquity of the Surriah Siddhanta admit, that its doctrines have been followed by Indian Chronologists from so early a period as A. D. 538, to the present times; whilst other no less respectable authorities, without going the length of supposing that it was revealed in the 17,27900th year of the *Treta yug*, have thrown that Epoch so far back as A. A. C. 2041, that is to say, 311 years after the universal deluge. But confining ourselves to the most moderate of these computations, it will no doubt be admitted that a system of Chronology which has lasted 1287 years (A. D. 1825), and according to which almost every Kalendar that has been used in India (*), whether Solar, Luni-solar, or Planetary, was constructed, was well worthy of investigation; for its application cannot fail to find materials for consideration, little doubt existing in my mind but that the dates of many considerable events recorded in Indian history lie hid from Europeans, or are much mistaken by them, for want of a competent instrument for unravelling the various Kalendars which have passed through their hands during the last century.

Not considered in this paper.

The Solar Sydereal system supposed to have been introduced in A. D. 538.

Uncertainty of the methods hitherto used for expounding ancient Hindu dates.

The Ayanansa, the principal Element used in this research.

As the problem under consideration depends chiefly on the relative position of the Hindu Sydereal and Tropical Ecliptic, the *Ayanansa* or Arc of distance between the Vernal Equinoctial point, and the 1st in the Solar Sign Mesha ♈, is an Element which, (as it is understood by the

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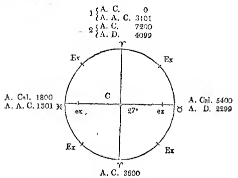
(*) In the country called *Malayala*, extending along the greatest part of the Coast of Malabar between Mangalore and Cape Comorin, the Natives reckon time from the birth of *Purasurama*, which they divide into Cycles of 1000 years. The years of that Epoch begin on the Sun's entrance into the Sign *Canya* ♍, which answers to the month *Aswini*, the sixth in the present order of the Solar months. Dr. Buchanan has calculated that in the month of September A. D. 1800, two complete Cycles had expired since the Epoch, and that the year beginning was the 977th of the third. This computation throws, therefore, the birth of Parasurama in A. A. C. 1176. I regret that my ignorance of the existence of that style when I was on the Coast of Malabar, prevented me from enquiring into the particulars of the *Malayala* Kalendars. I believe however, that their circulation is very confined, for in the Northern Provinces of that Coast the Natives chiefly reckon from the birth of Salivahana.

modern Hindu Astronomers) must be clearly defined; therefore, although I have already spoken of it at page 84 and other parts of this collection, I shall give here a detailed account of its Phases, without pretending, however, to decide on the grand question whether the original invention of Hindu Astronomy conceived it to librate in an Arc of 27° of the Ecliptic on each side of ♈, to revolve in an Epicycle about the same point as a center, or to move round the Platonic Cycle in a period of 24000 years.



Phases of the Ayanansa, whether supposed to move in an Epicycle, or to librate on each side of ♈ in the Hindu Sydereal Ecliptic.

If the Ayanansa be considered to revolve in an Epicycle, let each of the Quadrants ♈♓, ♈♉, be supposed to be equal to an Arc of 27° of the Deferent: but if it be supposed to librate from C to ♉, and from C to ♓, let the radius C♉, or C♓ be divided into 27 parts, each equal to 1° of the Ecliptic, and to either supposition what follows will apply.

Imagine a point Ex in the circumference of the Epicycle, or another ex in its diameter, revolving in one supposition from ♈ to ♓, or in the latter from C to ♓, at the annual rate of 54″ of a degree, the Indian *Cranti-Patagati*, or precessional variation.

First Padah or Quadrant.

Then in the Epicircular hypothesis from the year 0 to 1800 of the Cali yug complete, Ex (and ex in the libratory) will have moved through an Arc equal to 27° of the Deferent or Ecliptic, contrary to the order of the Signs: and as in the first and second Quadrants the Ayanansa is *negative*, the Tropical Longitude of the Vernal Equinoctial point at the beginning of the year, or (as Europeans would consider it) that of the beginning of the Sydereal Zodiac would be 12ˢ — 27° = 11ˢ 3°, shewing that the Equinoxes were then in 3° of Min ♓ and of Canya ♍.

2d Padah or Quadrant.

From this limit, which it is supposed never to exceed, or from the year 1800 to 3600 of the Cali yug complete, the Ayanansa will have decreased until Ex coincided with ♈ in the lower part of the Epicycle (or ex with C) when it became again equal to zero.

The Ayanansa positive or negative.

The Longitude of ♈ is the Supplement of the Ayanansa to 12s. when it is *negative*.

The Longitude of the same is equal to the Ayanansa when the latter is positive.

It is to be observed that during the two first Padahs, or Quadrants, although Ex in the first, moved contrary to, and in the second according to the order of the Signs, yet as in both cases it lies West of ♈, it is *negative;* therefore the Longitude of the first point of the Sydereal Ecliptic, is the *Supplement* of the Ayanansa to 12 Signs. And for the same reason, because in the third and fourth, Ex lies East of *the same*, moving in the direction of, in the 3d, and *contrary* to, the Signs in the 4th, the Ayanansa becomes *positive* (i. e. from A. Cal. 3600 until 7200), during which interval the Longitude and the Ayanansa are one and the same thing.

Third Padah or Quadrant of the Ayanansa.

It need hardly be added that when Ex, after having passed ♈ (or ex, C) coincides with ♉, which will occur when 5400 years of the Cali yug have expired, then its Ayanansa and Longitude will be + 27°, shewing that the Equinoctial points will then be in 27° of Vrisha ♉,

Fourth Padah or Quadrant.

and Vrischica ♏; and lastly, that when 7200 years of the Cali yug have expired, Ex will have regained ♈ in the superior part of the Epicyle (or ex, C), and therefore the Ayanansa, as well as the Tropical Longitude of the first point in the Sydereal Zodiac, will be equal to *zero*.

In the 2d and 3d Quadrants of the Ayanansa the Hindu and European precessional variation may be compared by one single operation.

As the Supplement of the Ayanansa to 12 Signs, in the 2d, and the Ayanansa itself, in the 3d Quadrants of the Epicycle, increase in the same manner as the European precessional variation, the Arc of distance between the first point of the Sydereal Ecliptic and the Equinox Ex (i. e. between A. A. C. 1301 and 2299) in the said Padahs, may easily be compared to the Tropical Longitude of the same point, computed by means of the European Tables.

In the 1st and fourth, it requires two,

But as in the 1st and 4th Quadrants (i. e. from A. A. C. 3101 to 1301 *complete* in the *first*, and from A. D. 2299 and 4099 in the *fourth)* the Hindu theory supposes that Ex, or ex returns towards ♈ or C, with contrary Signs; whereas by the European doctrines, these continue to recede therefrom according to the laws of the precessional variation, until Ex or C have reached their greatest elongation in the *great* scope which they have to describe, the Equation of the Ayanansa to the European Tropical Longitude at either season is of course equal to *nearly* twice the Cranti-Patagati (the motion of the Equinoctial points) due to the number of years elapsed between A. A. C. 3101 and 1301 in the first Quadrant, or between A. D. 2299, and 4099 in the fourth; as shall be shewn hereafter.

From what has been said it follows, that if any document could appear, which should bear as its *only* distinguishable date, the Sun's place in the Indian Sydereal Ecliptic, according to the fictitious system of the Ayanansa, in any year comprised in the said first and fourth Quadrants, another Eqvation would be required to refer the mean Longitude of Ex (or *ex*) in the Sydereal Zodiac to its *true Longitude* in the European Tropical Ecliptic.

The problem under consideration demonstrated by the result of several Examples.

As this work has principally *practice* for its object, instead of giving an analytical demonstration of the problems under consideration, I shall disclose the theory on which they rest by a number of Examples, which will present them under every aspect that such *questions* may assume: and it will be found in the present case, as in every other treated of in this collection, that the most difficult task imposed on the reader as well as the author, does not arise from the application of deep scientific knowledge, but from the difficulty of exposing briefly, and understanding clearly, methods which have little analogy with those used by European mathematicians.

The Hindu Tropical Longitude of any point of the Ecliptic deduced from its position in the Hindu Sydereal Ecliptic, by means of the Ayanansa.

To find the Tropical Longitude of any point of the Hindu Sydereal Ecliptic, as computed by the Native Astronomers, presents no sort of difficulty: the problem consists merely in the computation of the Ayanansa explained at page 86, and rendered still more easy by Table XXXV, and in adding the same if *positive*, or its Supplement to 12 Signs if *negative*, to the proposed Sydereal Longitude in the Ecliptic, if it be occupied by the Sun, or in the Orbit of the Planets if these be considered, referring it however, to their obliquity with the Ecliptic in the latter case. The sum of the *Ayanansa* and *Madhyama* Graha (mean place in the Sydereal Zodiac) is what the Hindus call the *Sayana* or Tropical Longitude of the Aster when in the proposed point, which they no longer count by the names of the Solar signs Mesha, Vrisha, Midhuna, &c. but by I, II, III, &c. as European Astronomers are in the habit of doing.

As also that of the Planets.

The Hindus count the Signs of their Tropical Ecliptic by their numerals.

Reduction of a point in the Hindu Sydereal to the European Ecliptic, considered.

But the present question involves one consideration more, namely, *how to deduce at once the European* Tropical mean Longitude of a point given in the Hindu Sydereal Ecliptic, without any other reference to the Indian Tropical Zodiac than the consideration of the Ayanansa at the beginning of the Hindu Solar year when the Sun is in the proposed point of his Orbit.

Elements. Value of A. and S.

The operation which forms the subject of this paper depends entirely on an annual Equation of $1'\ 45'',6$ European time ($4^v\ 24^p,04$ Hindu time $=$ a) amounting in a century to $2^h\ 56'\ 1'',6$ European time ($7^g\ 20^v\ 4^p$ Hindu time $=$ S) to be applied ± to the time when, according to the Hindu computation, the Sun occupies the proposed point, as shall be shewn hereafter. But the Longitude deduced from the time so equated is subject to a small reduction, by drawing the same into $\frac{54''}{54''\ 1'''\ 15''''}$, as it answers to a precessional variation greater by $1'''\ 15''''$ than $54''$ per annum. (*)

Reduction of the precessional variation supposed to be $54''\ 1'''\ 15''''$ to $54''$.

General View of the Proposition.

Epoch when S and a = o.

A. C. 5621, 7th Pausha.

A. D. 2519, 14th December, Julian Style; 28th December, Gregorian Style.

It was found in the course of this research that the European Tropical Longitude of the Sun, when in a certain point of the Hindu Sydereal Ecliptic which corresponds in time to the 14th December of A. D. 2519, *Julian* Style (†) at $18^h\ 53'\ 14''$ P. M. under the Meridian of Paris, will be precisely the same as that which would result if computed by the Ayanansa due to the beginning of the 5621st year of the Cali yug; *plus* the Sun's mean motion for $253^d\ 7^h\ 18'\ 54'',6$ ($18^g\ 17^v\ 17^p$ Hindu time) at Lanca. But it was also found, as stated in the present page, that the

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(*) This part of the Equation is subtractive when the Longitude equated by means of S and a, which gives always that which would result of a precessional variation of $54''\ 1'''\ 15''''$, is greater than by $54''$, and vice versa: but the multiplication by $\frac{54''}{54''\ 1'''\ 15''''}$ is dispensed with by help of Table XXXVI.

(†) 28th December, Gregorian Style.

divergence of the European Tropical, and Hindu Sydereal Solar Tables, *from that instant of time* increases precisely at the rate of $1' \, 45\frac{1}{2}''$ per annum; it follows therefore, that if this Equation, which I call a, its multiples or fractions, be applied with contrary Signs in ascending and descending years, to the time when the Sun, by the Hindu *account*, is in the proposed point of the Sydereal Ecliptic, his Longitude answering to the time so equated, drawn into $\frac{51''}{[illegible]}$ will be the same as would result from its being computed with reference to the *Ayanansa*, the difference of the proposed Hindu and equated time shewing the error of the Indian Solar Tables.

How to compute the error of the *Hindu Solar Tables* on which the Kalendar is constructed.

If therefore, the remoteness of an Epoch (A. D. 2519) which is thrown so far off from our times; and the inconveniency of a broken period of 253 days, &c. *from the commencement of the Hindu Solar year*, were not a strong objection against its being resorted to, the following general formula would be found to apply to all past and future times.

General formula.

$$T = \beta \pm (SnC + ma) \pm dx$$

where β represents the time when the Sun is in the *proposed point of the Ecliptic*. S = the secular Equation $7^{S}\ 20^{v}\ 1^{p}$ Hindu time; SnC = any multiple of the same; a = the annual Equation $4^{v}\ 21^{p},01$ Hindu time; ma = any multiple of the same (*); dx = the correction adverted to in the note at the foot of the preceding page; and T = the equated time sought, which will indicate the error of the Hindu Solar Tables.

Its notation.

The broken period of 19 years, $348^{d}\ 10^{h}\ 53'\ 14''$ referred to the Julian year and Meridian of Paris (preceding page), or of $253^{d}\ 7^{h}\ 18'\ 54'',6$ referred to the time of the commencement of the Hindu Solar year 5621, may easily be done away, by referring the above formula to the beginning of the century (A. D. 2500), which would then correspond to the 5602^{d} year of the Cali yug; for say

14th December (the 348th day of the year) answering to 7th Paushia.

365^{d} (one common year): $4^{v}\ 24^{p},04$ :: $19^{y}\ 253^{d}\ 18^{g}\ 17^{v}\ 17^{p}$ :: $1^{g}\ 26^{v}\ 40^{p}$, which last term calling Δ, the new formula for all years ascending from A. C. 5602 (A. D. 2500) will be,

Formula for all years ascending from A. C. 5602, A. D. 2500.

$$T = \beta + SnC + \Delta + ma \pm dx$$

and it will be found sufficiently accurate for all practical purposes.

But these Epochs are too remote from our times, not to be extremely inconvenient in practice. In the following tract, I have therefore referred the general formula to two different Epochs, viz. to the year of Christ 1700 for ascending, and 1800 for descending Julian years, the intermediate Hindu Solar years which concur with those of the 18th Christian century, being subject to two special formulæ, reducible as the others to the general one.

Other Epochs preferred, the formula adapted to the same.

In all cases it is to be understood, that the Julian Kalendar alone *is to be referred* to in the resolution of problems depending on the Sun's position in the Hindu Sydereal Ecliptic, on account

The Julian Kalendar alone is to be used in the resolution of questions.

(*) In case of fractions of years $\frac{a}{365}$ will be found equal to 0p,7233, the equation for one day, and 1v. 12p,3418 for 100d. from which the fraction for any number of days may easily be deduced.

of the 25 Bissextile years of that style in a century (all Secular years being Leap ones) and the invariable regularity of its construction.

The application of the method under consideration supposes a knowledge of the use of the European Solar Tables, which implies no great degree of science, for all that is required of the computer is, that he should know how to find the Sun's mean Longitude for any year, day or instant that may be proposed. (*)

Notation, Formulæ, and Examples.

The foregoing introduction seeming sufficient to give a general notion of the nature of an instrument which I have used with success for the resolution of some very remote and obscure cases, I shall now proceed to shew how it is to be handled, and conclude by shewing its application.

It is to be regretted that the remoteness of the Epoch to which the general formula refers has necessitated the splitting of it, into several special formulæ, which give an appearance of complexity to the problem, which in reality it has not, and which has increased the notation beyond the usual measure; but if the reader has the patience of expounding a couple of cases, he will soon find that the process is by no means a delicate one, and that he need not be detained more than a quarter of an hour on any one case that can be proposed.

Instead of presenting the formulæ collectively, I have separated them into several propositions, which will render the references easier, and prevent confusion.

Notation.

Let β represent any time according to the Hindu Solar Sydereal Kalendar, where the year consists of $365^d\ 15^g\ 31^v\ 15^p$, the Hindu monthly date being previonsly expounded into its concurring European date according to the Julian Kalendar, (vide Key to the Madhyama Saura mana), but the fractions of days remaining expressed in guddias, viguddias and paras.

$S =$ The secular Equation $7^g\ 20^v\ 4^p$ Hindu time ($2^m\ 56'\ 1'',6$ European time) mentioned at page 249.

$nC =$ Any number of centuries.

$a =$ The annual Equation $4^v\ 21^p,01$ Hindu time ($1'\ 45'',5$ European time) mentioned at the same page.

$\frac{a \times D}{365} =$ The same Equation for any number of days not exceeding one year.

$ma =$ Any number of years not exceeding a century.

(*) As all sorts of Tables are scarce in India, I have compressed Delalande's four first Tables (Edition of 1764) into two, and added at the foot directions for using them; these will be found in Table LII, part 1st and 2d.

A= A constant Equation applicable to all years ascending from the 4802d of the Cali yug (A. D. 1700) =7^{v} 12^{p} Hindu time (2 52′ European time).

B= A constant Equation applicable to all years descending from the 4902d year of the Cali yug (A. D. 1800) =7^{g} 12^{v} 52^{p} Hindu time (2^{h} 53′ 8″,6 European time.

E= A constant Equation applicable to all Hindu Solar years from the 4804th to the 4899th year of the Cali yug (A. D. 1702 to 1799) answering to the 97 last years of the Christian 18th century =1^{v} 36^{p},08 Hindu time (24″,2 European time).

y= An Equation applicable only to the 4803d year of the Cali yug (A. D. 1701) =2^{v} 47^{p},66 Hindu time (1′ 17″,1 European time).

△= A constant Equation, being one of the terms of the formula which applies the computations referred to the 5602d year of the Cali yug (A. D. 2500) =1^{g} 26^{v} 40^{p} Hindu time (34′ 40″ European time) as stated at page 250.

x= The general multiple $\frac{54''}{54^{\circ}\,1'\,15''}$ mentioned at page 219.

dx= A correction which dispenses from using the multiple x, being the difference of the Ayanansas given in Tables XXXV and XXXVI, to be applied ±, as stated in the note at the foot of page 249.

H= 6 hours (constant).

L= The difference of Longitude in time between Paris and Lanca (constant).

T= The time sought.

N. B.—As H and L are constant quantities, and are applied in the same manner in all cases, they are not considered in the formulæ, although they are always used in expounding them.

Proposition I.

Special formula for all years ascending from 5602 Cali. A. D. 2500, to any assignable time.

" If to the time of the beginning of the 5602d year of the Cali yug (A. D. 2500) you add the
" constant quantity 1^{g} 26^{v} 40^{p} (34′ 40″) △; and if for any other Solar Sydereal year ascending
" therefrom, besides the said quantity △ you add 4^{v} 21^{p},04 (1′ 45″,616 European time) a
" for each year; and 7^{g} 20^{v} 4^{p} (2^{h} 56′ 1″,6) S for each century, the Sun's mean Longitude due
" to the time so equated drawn into $\frac{54''}{54^{\circ}\,1'\,15''}$ will be equal to the Ayanansa or its Supplement
" for the beginning of the said Solar year."

" And the general formula for all years not exceeding the 5602d of the Cali yug will be

$$T = \beta + (SnC + \triangle + ma) \pm dx \ (*), \ (\text{page } 250)$$

(*) The term dx is the difference of the Ayanansa given by Tables XXXV and XXXVI converted into time by means of Table LXI, and dispenses from drawing the Sun's Longitude due to the equated time into $\frac{54''}{54^{\circ}\,1'\,15''}$. It is additive when the *Ayanansa* or its Supplement to 12 Signs (when it is negative) is greater than that given by Table XXXVI, and subtractive when it is less.

where nC represents the number of centuries, and m the number of years between that which is proposed, and the Epoch 5602.

PROPOSITION II.

Special for all years ascending from A. Cali 4802, A. D. 1700, to any assignable time.

" If to the commencement of the 4802ᵈ year of the Cali yug (A. D. 1700) you add one day " and the constant quantity $7^s\ 12^d$ ($1^h\ 45',6$ European time) A; and if besides the said quan- " tity, you add for any other year ascending therefrom the value of a for every year, and of S " for every century as above noted, the Sun's mean Longitude due to the time so equated drawn " into $\frac{54''}{54''\ 1'''\ 15''''}$ will be equal to the Ayanansa, or its Supplement to 12 Signs if it be negative, " for the beginning of the said Solar year.

Not exceeding A. C. 1800 complete, A. A. C. 1301.

" The formula for all years *ascending* from A. C. 4802 (A. D. 1700) to any Epoch not " exceeding A. C. 1800 (A. A. Christ. 1301), will be

$$T = \beta + 1^{day} + (SnC + A + \overset{*}{ma}) \pm dx$$

" the notation remaining as before.

" The formula for A. C. 4802 (A. D. 1700), is therefore merely

$$T = \beta + 1^{day} + A - dx.$$

PROPOSITION III.

Special for all years descending from A. C. 4902, A. D. 1800.

" If to the commencement of the 4902ᵈ year of the Cali yug (A. D. 1800) you add 1 day, " and from the sum you subtract $7^s\ 12^\circ\ 52'$ ($2^h\ 53'\ 8''$,6 European time) B; and if besides the said " constant quantity you subtract furthermore the value of $\underline{a}$ for each year, and of $\underline{S}$ for each " century *descending*, the Sun's mean Longitude due to the time so equated drawn into " $\frac{54''}{54''\ 1'''\ 15''''}$ will be equal to the Ayanansa for the beginning of the said Solar year.

" The formula for all years *descending* from A. C. 4902 (A. D. 1800) to any year not " exceeding A. C. 5400 (A. D. 2299), will therefore be

$$T = \beta + 1^{day} - (SnC + B + ma) - dx$$

and for the 4902ᵈ (A. D. 1800)

$$T = \beta + 1 - B - dx.$$

The Hindu Solar years which concur with those of the XVIIIth century, may all be equated by means of the first or general formula,

$$T = \beta + SnC + \Delta + ma - dx;$$

but the same may be done by means of the following special formulæ.

PROPOSITION IV.

Special for the year of the Cali yug 4803, A. D. 1701 only.

" If to the commencement of the 4803ᵈ year of the Cali yug (A. D. 1701) you add *one*

(*) In Bissextile years ma = 0.

" day and 2' 47",06 (1' 17",1 European time) x, the result will be the same as in the foregoing " propositions, and the formula for *that particular year* will be

$$T = \beta + 1 + x - dx.$$

PROPOSITION V.

Special for all years from A. Cal. 4804 to 4901, A. D. 1702 to 1799.

" If from the commencement of the 4804th year of the Cali yug (A. D. 1702) you subtract the " constant quantity 1' 36",08 (24",2 European time) E; and if for the remaining years down " to A. C. 4901 (A. D. 1799) you subtract furthermore the value of $\underline{a}$ for each year descending, " the results will be as before stated, and the formula

$$T = \beta + 1^{\text{day}} - (E + mn) - dx.$$

OBSERVATION.

The limits in Propositions III and IV explained.

It will have been remarked in Proposition III, that the rule answers no higher than the 1800th year of the Cali yug *complete* (A. A. C. 1301); and in Proposition IV, no lower than the 5400th Cal. complete (A. D. 2299), whereas at Proposition I, it is extended up to A. C. 5601 (A. D. 2500) *complete*, or the beginning of the 5602d; and that no limits were fixed for ascending years, but the restrictions at Propositions III and IV proceed, from the supposed Epicircular, or Libratory motion of the Equinoctial points, which are only retrogade in the 2d and 3d Quadrants of the Ayanansa, and consequently progressive in the two others, so as to return in a contrary direction towards *zero*.

Case where the Hindu, is supposed to proceed in a contrary direction from the European, precessional variation.

But although we should use the Ayanansa Table for finding the Longitude of the 1st point of Mesha ♈ on the beginning of any Solar year, according to the erroneous notions of the Indians, yet as the Hindu difference of the *true* and *supposed* Longitude is always equal to double the quantity of precessional variation (Cranti-Patagati) due to the interval elapsed between the passing of Ex either into the 1st Quadrant, in *ascending*, or into the 4th in *descending* years, having established that constant ratio, the formula will still hold good.

For let the Ayanansa for the 1599th year of the Cali yug complete (A. A. C. 1100) be by the Tables (and according to Hindu theory) 23° 59' 6"; say from 1200 to 1599 there are 201 years, for which the motion of the Equinoxes is 201×54" = - - 3° 0' 54"

				× 2
The double of which - - - -		6	1	48
Added to the supposed Ayanansa - - -		23	59	6
Gives the true Hindu Longitude sought - -	1'	0	0	54

to which the time equated by the formula will correspond.

SECTION I.

EXAMPLE I.

Let it be required to compute the time at Paris when the Sun's mean Longitude is equal to the

Examples for Hindu Solar years concurring with Christian Secular years O. S.

Ayanansa on the beginning of the Hindu Solar Sydereal year 4802 of the Cali yug, answering to A. D. 1700, a Bissextile year O. S.

Cali yug 4802, A. D. 1700 Secular.

The formula in the present case is (page 253.)

$$T = \beta + 1^{day} + A - dx. \quad \text{(Proposition II.)}$$

Time of commencement of the Solar year 4802 expounded in the usual manner.

		G.	V.	P.	
β = March	28	46	40	0	
+ 1	1				
+ A			7	12	
Hindu time	29	46	47	12	
		h	'	"	
The same European time	29	18	42	52	
Subtract, to count from noon, H	—	6			
	29	12	42	52	p. m.
Longitude in time between Paris and Lanca, L	—	4	54	12	
Equated time uncorrected, March	29	7	48	40	p. m.

when the Sun's mean Longitude is equal to the Ayanansa such as given in Table XXXVI, and will be found to be 18° 1′ 19″,9 which drawn into $\frac{54'''}{54''\ 1'''\ 15^{iv}}$ = 18° 0′ 53″,8.

Ayanansa and Longitude of the first point in Mesha ♈ 18° 0′ 54″.

In order to save the trouble of the latter operation, say

Table XXXV,	Ayanansa A. C. 4802	18°	0′	54″,0
XXXVI,	do. do.	18	1	19,9
	Difference dx			25,9 (*)

and the time which the Sun will take to move through that number of seconds (Table LII) is 10′ 31″, which subtracted from March	29	7ʰ	48′	40″
			10	31
Leaves the true equated time T = March	29	7	38	9

at which time the Sun's mean Longitude (at Paris) will be found equal to the Ayanansa, as may be computed thus:

From 1st January to 29th March 89 days; but as the Sun's mean Longitude for 1700 in Table LII is given for noon 1st January (on account of the Bissextile), take only for 88 days.

	s	°	′	″
☉'s mean Longitude Table LII, 1st January 1700	9	20	57	51
For 80 days, part 2d	2	18	51	6,4
8 do. do.		7	53	6,6
7 hours			17	14,9
30 minutes			1	13,9
8 minutes				19,7
9 seconds				4
Sun's mean Longitude equal to the Ayanansa	0	18	0	52,9

differing only 1″,1 from that given in Table XXXV.

N. B.—The same calculated by Delalande's Tables gives exactly 18° 0′ 54″.

(*) Generally dx is subtractive when the Longitude given by Table XXXVI, is greater than that by Table XXXV, and vice versa.

SCHOLIUM.

According to the Hindu Kalendar the Sun is supposed to have entered the sign Mesha ♈ on the 28th March 1700 at $12^h\ 40'$ p. m. Meridian of Lanca (1º); but according to European computation, he only entered it on the 29th of the same month at $12^h\ 32'\ 21''$ also at Lanca; i. e. $23^m\ 52'\ 21''$ later: during which time the Sun would move through an A[illegible] of $58'\ 51'',4$. It follows therefore, that the Hindu Kalendar advances too much the Sun's position, since it assigns it $12^s\ 0^\circ\ 0'\ 0''$ when it is only $11^s\ 29^\circ\ 1'\ 8'',6$. Hence the correction of the Hindu Tables should be subtractive from the *Ayanansa*, or additive to the *time*.

		G.	V.	P.	
1º	28	46	40	0	from ⊙ rising.
To count from noon, subtract		— 15			
Hindu time - - -	28	31	40	0	p. m.
		H.	′	″	
European time - -	28	12	40	0	p. m.

2º		H.	′	″	
Equated time - -	29	7	38	9	p. m.
To reduce to Lanca -	+	4	54	12	
True time - - -	29	12	32	21	
Time as above - -	28	12	40	0	
Error in time - - -	0	23	52	21	

EXAMPLE II.

Cali yug 4902, A. D. 1800 Secular.

Let the same be proposed for the beginning of the 4902d year of the Cali yug, answering to A. D. 1800, being (according to the Julian Kalendar) a Bissextile year. (*)

The formula is $T' = \beta + 1 - B - dx$ (Proposition III).

Ayanansa.	°	′	″	‴
By Table XXXV,	19	30	54	0
do. XXXVI,	19	31	21	6
Difference			27	6

Answering to 11′ 0″ of time = dx.

Ayanansa and Longitude of ♈ 19° 30′ 54″.

			G.	V.	P.	
β =	March	29	38	45	0	
+ 1 -		1				
		30	38	45	0	
— B -		—	7	12	52	
In Hindu time		30	31	32	8	
In European time		30	12	36	51	from ⊙ rising.
Subtract, to count from noon, — H -		—	6			
		30	6	36	51	p. m.
Longitude in time between Paris and Lanca — L -			4	54	12	
		30	1	42	39	
— dx -			—	11	0	
Equated time, Meridian of Paris, T =		30	1	31	39	p. m.

(*) Not to repeat uselessly the same words, the time of commencement of the Hindu Solar Sydereal year, represented by β, will be supposed known. (Vide 1st Memoir.)

The process for finding the Sun's Longitude by the European Tables, or Table LII of this collection, being the same as in the preceding Example, need not be repeated. It gives 19ˢ 30′ 54″,2, differing only by 0″,2 from the Ayanansa.

EXAMPLE III.

The same for the commencement of the Solar Sydereal year 3102 of the Cali yug, answering to A. D. 0.

The formula is $T = \beta + 1 + SnC + A + dx$ (Proposition II), and in this case as the Ayanansa is negative, being in its second Padah, the difference of its Supplement to 12 Signs (or Longitude according to European expression) is to be taken for finding dx.

Cali yug 3102, A. D. 0 Secular.

OPERATION.

1700
0   nC = 17
(17) 00

		G.	V.	P.
S =		7	20	4
			×	17
SnC	2ˢ	4	41	8
+ A			7	12
SnC + A	2	4	48	20
+	1			
1ˢ + SnC + A	3	4	48	20

Longitude (*)

	ˢ	°	′	″
Table XXXV,	11	22	30	54
do. XXXVI,	11	22	30	43
Difference				11

		G.	V.	P.	
β = March	14	1	15	0	
1ˢ + SnC + A = +	3	4	48	20	
	17	6	3	20	
	17	2	25	20	from ☉'rising:
— H —	6				
	16	20	25	20	p. m.
— L —		4	54	12	
	16	15	31	8	
+ dx +			4	26	
T. Equated time, Meridian of Paris, March	16	15	35	34	p. m.

As the Epoch of this Example is very remote, I shall subjoin the computation of the Sun's Longitude by means of Table LII.

Ayanansa.	ˢ	°	′	″
	0	7	29	6
	12	0	0	0
Long.	11	22	30	54

From the beginning of the European year to the 16th March, 76 days: but as the proposed year is Bissextile, take for 75 days.

	ˢ	°	′	″
Table LII, ☉'s mean Longitude 1st January A. D. 0 -	9	7	57	5
do. part 2, for 70 days - -	2	8	59	43,1
5 do. - - -		4	55	41,6
15 hours - - -			36	57,7
30 minutes - - -			1	13,9
5 do. - - -				12,3
30 seconds - - -				1,2
4 do. - - -				0,2
Sun's Longitude by the European Tables -	11	22	30	55,0

differing from the Supplement of the Ayanansa by 1″.

(*) In the first and second Padah of the Ayanansa, the Sun's Longitude on the 1st Vaisacha, is its Supplement to 12 Signs. In the third and fourth the Ayanansa and Longitude are the same.

SCHOLIUM.

By the Hindu Kalendar, the Sun is supposed to have entered the sign Mesha ♈ on the 13th March A. D. 0, at 18ʰ 30′ p. m. at Lanca (1º.), and the Sun's Longitude in the Tropical Ecliptic was 11ˢ 22° 30′ 51″ on the 16th of the same month at 20ʰ 29′ 46″ p. m. also at Lanca, by the European Tables (2º.). The difference in time is therefore 3ᵈ 2ʰ 0′ 14″, during which the Sun would move through 3° 2′ 21″ (Table LII, part 2), and as the Hindu Kalendar supposed the Sun to have 12ˢ Longitude, *three* days, &c. *before* he was actually thus much advanced in the Ecliptic, it follows that the error of the Hindu Tables is *subtractive* of the *Longitude* and consequently *additive* to the *Ayanansa*, as well as to the time registered in the Kalendar.

		G.	Y.	P.	
1º. March	14	1	15	0	from ☉ rising
	—	15	0	0	
	13	46	15	0	p. m.
	13	18ʰ	30′	0″	
2º. March	16	15ʰ	35′	34″	p. m
	+	4	54	12	
	16	20	29	46	Lanca.
	13	18	30	0	
Error in time =	3	2	0	14	

EXAMPLE IV.

Cali yug 5102, A. D. 2000 Secular. The same for the commencement of the 5102ᵈ year of the Cali yug, answering to A. D. 2000, a Bissextile year.

The formula is T = β + 1ᵈᵃʸ — (SnC + B) — dx. (Prop. III.)

OPERATION.

2000 nC = 2 B = 7ˢ 20ᵛ 4ᵖ
1800
(2)00

Ayanansa.
Table XXXV, 22° 30′ 54″
do. XXXVI, 22 31 25,2

Difference 31,2
The time due to which is 12′ 15″ = dx,

S = 7ˢ 20ᵛ 4ᵖ
× 2
14 40 8
+ B. 7 12 52
SnC + B = 21 53 0

		G.	Y.	P.	
β = March	31	22	55	0	
+ 1 day	+ 1				
April	1	22	55	0	
— SnC + B		— 21	53	0	
Hindu time, April	1	1	2	0	
European time	1	0	24	48	
— H - -		— 6			
March	31	18	24	48	p. m.
— L - -		— 4	54	12	
	31	13	30	36	
— dx - -			— 12	15	
Equated time at Paris, T = March	31	13	18	21	p. m.

and whether we resolve the Sun's mean Longitude by Delalande's Tables, or by Table LII,
Ayanansa and Longitude 22° 30′ 54″. we shall find it to be 22° 30′ 54″,8, differing from the Ayanansa (which is also the Longitude of the 1st point in Mesha) by 0″,8.

The error of the Kalendar may be deduced in the same manner as before.

SECTION II.

Examples for Hindu Solar years, corresponding to European Julian years which are Bissextile without being Secular.

How to equate the commencement of Hindu Solar years concurring with Christian Bissextiles *not* Secular.

EXAMPLE V.

Let it be proposed to equate the commencement of the 4782^d year of the Cali yug, answering to A. D. 1680.

Cali yug 4782, A. D. 1680 Bissextile.

The formula in this case is T = β + 1^d + (SnC + A + ma) — dx. (Prop. II.)

OPERATION.

```
1700
1680       nC = (0)     m = 20   ma = 20 × 4g 24v,04 = 1g 28v 0p
----                                                    G.  V.  P.
(0)20      A = 7v 12p         Ayanansa.         β March  28  36  15  0
                       Tab XXXV,17°42′54″  0‴  + 1 day   +  1
           A  = 7  12  do.XXXVI, 17 43 18 35+SnC+A+ma+1  35  12
 +     ma = 1 28   0                                    ----------
                         — 24 35   Hindu time   29  37  50  12
SnC+A+ma    1 35  12                                    ==========
                  Answering to 9′ 57″ = dx.
                                     Eur. time  29  15   8   5 from ⊙ rising
                                      — H       —    6
                                                ----------
                                                29   9   8   5 p. m.
                                      — L            4  54  12
                                                ----------
                                                29   4  13  53
                                      — dx               9  57
                                                ----------
         Time equated, Meridian of Paris, T= March  29   4   3  56 p. m.
                                                ----------
                                                 s.   °    ′    ″
⊙'s Longitude 1st January 1600, Table LII, part 1, div. 2,   9  20  11  56
                                   div. 3, 80 years,               36  44,53
       Part 2, for 88 days, 4h 3′ 56″ (d. 1, 2, 3 and 4),   2  26  54  14,2
                                                ----------------
⊙'s mean Longitude, differing only from the Ayanansa by 0″,73,  0  17  42  54,73
```

Ayanansa and Longitude 17° 42′ 54″.

EXAMPLE VI.

The same for the commencement of the 4918th year of the Cali yug, answering to A. D. 1816, a Bissextile.

A. C. 4918, A. D. 1816 Bissextile.

Formula T′ = β + 1 1^d — (SnC + B + mb) — dx.

OPERATION.

```
1816
1800       nC = 0.   m = 16.   mb = 16 × 4g 24v,04 = 1g 10v 24p
----
(0)16
             G.  V.  P.                                    G.  V.  P.
      B =    7  12  52         β =              March  29  47   5   0
     mb =    1  10  24         + 1 day    -   -             1
            ----------                                 -------------
SnC + B + mb  8  23  16                                30  47   5   0
  Ayanansa.   °   ′   ″   ‴    —SnC + B + mb           —   8  23  16
 Table XXXV, 19  45  18   0                            -------------
 do.  XXXVI, 19  45  45  26    Equated Hindu time     30  38  41  44
             --------------                            =============
                   — 27  26                                 H.  ′   ″
which answers to 11′ 8″ of time = dx.
                          do. European time  30  15  28  41 from ⊙ rising.
                                 — H     -   —    6
                                            -------------
                                             30   9  28  41 p. m.
                                 — L     -   —    4  54  12
                                            -------------
                                             30   4  34  29
                                 — dx    -        —  11   8
                                            -------------
     Equated time, Meridian of Paris, T = March  30   4  23  21 p. m.
```

Ayanansa and Longitude 19° 45′ 18″.

	s.	°	′	″
☉'s mean Longitude 1st January 1800, Table LII, -	9	21	43	47
Part 1st, do. for 16 years			7	20,9
Part 2d, for 89 days, 4 hours, 23 minutes, 21 seconds -	2	27	51	10,2
☉'s mean Longitude at equated time -	0	19	46	18,1

differing only 0″,1 from the Ayanansa.

The foregoing six Examples provide for every case of Hindu Solar Sydereal years corresponding to Christian years which are either Secular or Bissextiles. As for the common years the rule is the same, observing that in *ascending* years from A. D. 1700, the term m a of the first formula, applies to the number of years counted from the end of the century giving the years which are wanting to complete it; and m b of the second, to the number of years counted from the beginning of A. D. 1800 to the proposed one. I shall give a few Examples of the case of Hindu Solar corresponding to common European years, for the purpose of shewing how the Sun's mean Longitude according to European Astronomy, is to be computed by means of Table LII. (*)

SECTION III.

Examples for Hindu Solar years which correspond with common Christian years before and after Christ.

Example for a year before Christ.

EXAMPLE VII.

A. C. 3101.
A. A. C. 1.
B. C. and common.

Let it be proposed to equate the commencement of the 3102d year of the Cali yug, answering to A. A. C. 1 current, a common year.

It will be found by Table VIII (page 10 of the Tables), that the Initial Root for that year is Friday, at $45^g\ 43^v\ 45^p$ after Sun rise; and by Table V, part 3d, that this Friday falls on the 14th *March*, which gives the value of β in the formula $T = \beta + 1 + (SnC + A + ma) + dx$ (Prop. II).

Ayanansa.

	s.	°	′	″
		7	30	0
	12s	0	0	0
Long.	11	22	30	0

OPERATION.

1700
+ 1 $nC = 17$. $m = 1$. $ma = 4^v\ 24^p,01$.
(17) 01

	g.	v.	p.
S	7	20	4
		×	17
SnC 2^d 4	41	8	
+ A		7	12
ma		4	24
2 4	52	44	
SnC+A+ma			

Longitude deduced from Ayanansa.

	s.	°	′	″	‴
Table XXXV,	11	22	30	0	0
do. XXXVI,	11	22	29	40	35
Difference +				10	25

Answering to 4′ 12″ in time = dx.

		g.	v.	p.	
β March	14	45	43	45	
+ 1 day +	1				
+SnC+A+ma	2	4	52	44	
Hindu time	17	50	36	29	
European time	17	20	14	36	from ☉ rising
— H	—	6			
	17	14	14	36	p. m.
— L	—	4	54	12	
	17	9	20	24	
+ dx			4	12	
Equated time, Meridian of Paris, T = March	17	9	24	36	p. m.

(*) The author begs here to remind the reader, that he is not writing for the purpose of instructing Astronomers, but merely to give to those who are not, the means of using his Tables and Formulæ.

which rule differs in no respect from the preceding; but in order to find the Sun's mean Longitude by means of Table LII, which is the same as that deduced from the Ayanansa, we are to proceed as follows:

	s.	°	′	″
Part 1, ☉'s mean Longitude 1st January, div. 1, - - -	9	7	57	5
☉'s motion for one year ascending, div. 4, - - -		—	44	48,8
☉'s mean Longitude 31st December A. D. 0, -	9	7	12	16,2
And there being from that date to March 17th, 76 days, we have by part 2 (out of the respective divisions) for $76^{d}\ 9^{h}\ 24'\ 36''$ - - -	2	15	17	44,3
☉'s mean Longitude sought, -	11	22	30	0,5

which differs only from that deduced from the Ayanansa by $0'',5$.

EXAMPLE VIII.

A. C. 4743, A. D. 1641 common.

The same for the commencement of the 4743d year of the Cali yug, corresponding to A. D. 1641, a common year.

Formula $T = \beta + 1 + (SnC + A + ma) - dx$ (Prop. II.)

OPERATION.

Ayanansa and Longitude 17° 7′ 48″.

Aynnansa and Longitude.

	°	′	″	‴
Table XXXV,	17	7	48	0
do. XXXVI,	17	8	11	46
difference		—	23	46

answering to 9′ 34″ of time.

As this case offers nothing new, I shall be contented with stating that $nC = 0$; $m = 59$; $ma = 4^{g}\ 19^{v}\ 33^{p}$; $SnC + A + ma = 4^{g}\ 26^{v}\ 50^{p}$; $dx - 9'\ 34''$; and β, by the usual process, being found to answer to March 28th, $30^{g}\ 56^{v}\ 15^{p}$, the time after noon equated to the Meridian of Paris is March 29th, $3^{h}\ 5'\ 28''$, at which time the Sun's true Longitude by Delalande's Tables, or Table LII, will be found as follows:

	s.	°	′	″
Table LII, part 1st, div. 1, ☉'s mean Longitude 1st January 1600 -	9	20	11	56
Do. do. div. 3, for 40 years - - -			18	22,26
Do. do. div. 4, for *descending* years, one year -	11	29	45	40,5
☉'s mean Longitude 31st December 1640 -	9	20	15	58,76
Part 2, (by the respective divisions) for $88^{d}\ 3^{h}\ 5'\ 28''$ - -	2	26	51	49,96
☉'s Longitude, differing $0'',7$ from the Ayanansa, -	0	17	7	48,72

SECTION IV.

How to equate the beginning of Solar years concurring with those of the 18th Christian century.

On the manner of equating the beginning of Hindu Solar years concurring with those of the XVIIIth Christian century.

We have already observed (page 253) that the term A of the first formula $(7^{v}\ 12^{p})$ applies to Solar years concurring with all Christian years ascending from A. D. 1700; and that B, of the second formula $(7^{g}\ 12^{v}\ 52^{p})$ to those corresponding to all Christian years descending from A. D. 1800. We are now to consider the resolution of that part of the problem, which equates the commencement of Sydereal years from the 4802d to the 4902d of the Cali yug, corresponding with those of the European XVIIIth century; the mode of doing which differs only in appearance from the rest, for every thing still depends on the Secular Equation $S = 7^s\,20^v\,4^p$ and *its fractions*. The formula however, changes, as we have seen at page 251, and this is to be ascribed to the Signs passing from + to — during that interval, although if we were to begin from that Epoch where S, A, and B = 0, such a change would not occur, as shall be seen hereafter.

N. B.—It is to be remembered, that A is only equal to $7^v\,12^p$; and B to $7^s\,12^v\,52^p$ at the end of the 4801st and 4901st of the Cali yug. The passage from A to B will be explained in what follows:

		v.	p.
If from A, due to A. C. 4801 complete -	+	7	12
We subtract a - - -	—	4	21,04
We have the Equation for 4802 complete -	+	2	47,96
The difference of which to a - - -		4	24,04
Will be -	—	1	36,08

which is the Equation for 4803 *complete*, answering to A. D. 1702; from which year the Equation becomes negative. I shall therefore call the year 4804 *current* of the Cali yug, answering to A. D. 1702, the Epoch of the years concurring with those of the XVIIIth century, and its Equation $E = -1^v\,36^p,08$; that for the beginning of A. Cal. 4803 (1701) remaining peculiar to itself, viz. $+\,2^v\,47^p,96 = \text{y}$. (Proposition IV).

Cali yug 4804, A. D. 1702, Epoch for the Solar years concurring with those of the XVIIIth century.

The above considerations will lead us to determine the value of B for the Solar year concurring with A. D. 1800; for let us find the Equation for the commencement of the 4901st year of the Cali yug, answering to A. D. 1799.

The Equation for 4803 unique.

The values of E and Y referred to that of B in the 2d formula.

From the proposed year -	1799	
Subtract Epoch -	1702	
Interval -	97 years = m.	
Now multiply a ($4^v\,21^p$,04) - - - -		4 21,04
	by m =	× 97
		7^s 6 51,88
Add E (above found) - - - -		+ 1 36,08
Equation for 1799 - - -		7 8 27,96
To which add again a for *one* year - -		+ 4 21,04
Equation B, for 1800 - - - -		7 12 52,0

This being understood, so will the formula

$T' = \beta + 1 - (E + ma) - dx$. (Proposition V), for all the years of the Hindu account which concur with those of the XVIIIth century, except the 4803d of the Cali yug (1701), which retains its own Equation $+\,2^v\,47^p,96 = \text{y}$.

Formula for Solar years from 4804 to 4902.

Section V.

Example IX.

We shall first resolve the case of the beginning of the 4803d year of the Cali yug, answering to A. D. 1701, which, as already stated, is unique of its kind, the Equation being

Case unique. A. C. 4803, A. D. 1701.

$$T'' = \beta + 1 + \text{y} - dx. \text{ (Proposition IV.)}$$

Ayanansa and Longitude.

	°	′	″
Table XXXV,	18	1	48
do. XXXVI,	18	2	13,9
Difference			25,9

Answering to 10′ 31″ = dx.

			G.	V.	P.	
β =	-	March 29	2	11	15	
+ 1	- -	+ 1				
+ x	-	+ 0	0	2	47,96	
		30	2	14	2,96	
		30	0	53	37,2	from ⊙ rising.
— H	- -	—	6			
		29	18	53	37,2	p. m.
— L	- -		4	54	12	
		29	13	59	25,2	
— dx	- -	—		10	31	
Time P. M. equated to Meridian of Paris, T″	-	29	13	49	54,2	p. m.

And for the ⊙'s Longitude due to that instant according to the European Tables, we have

Longitude and Ayanansa 18° 1′ 48″,

		s.	°	′	″
Table LII, part 1, ⊙'s mean Longitude 1st January 1700	-	9	20	57	51
For one year, division 4, - - -	+	11	29	45	40,5
⊙'s mean Longitude 31st December 1699	-	9	20	43	31,5
Same Table, part 2, for 88d 13h 49′ 54″ -	-	2	27	18	18,1
⊙'s mean Longitude sought	-	0	18	1	49,6

differing from the Ayanansa on the beginning of A. Cm. 4803, by 1″,6, which is the maximum of deviation which has occurred in the course of this research, even for the remotest times, between the results of the formulæ, and those of the European Solar Tables.

Example X.

The same for the commencement of the 4804th year of the Cali yug, concurring with A. D. 1702.

Cases for the remaining years of the century.

Formula T = β + 1 — (E + ma) — dx (Prop. V.)

Here, as the proposed year is that of the Epoch (page 262) m and ma = 0, and E + ma = 1v 36p,08.

A. C. 4804, A. D. 1702, a common year.

Ayanansa and Longitude.

	°	′	″	‴
Table XXXV,	18	2	42	0
do. XXXVI,	18	3	7	3
	—		25	3

Answering to 10′ 10″ of time = dx.

		G.	V.	P.	
β = March	29	17	42	30	
+ 1 day -	+ 1				
	30	17	42	30	
— E + ma -		—	1	36,08	
Hindu time, March	30	17	40	53,9	
European time	30	7h	4′	20″	
— H -	—	6			
	30	1	4	20	p. m.
— L -	—	4	54	12	
	29	20	10	10	
— dx -		—	10	10	
Equated time, Meridian of Paris, T″ -	29	20	0	0	p. m.

Ayanansa and Longitude 18° 2′ 42″.

Aud for the European Tropical mean Longitude.

	s.	°	′	″
By Table LII, ☉'s mean Longitude 1st January 1700, -	9	20	57	51
For 2 years, do. div. 4, - - -	11	29	31	21
☉'s mean Longitude 31st December 1699 -	9	20	29	12
And by part 2, for 88 days, 20 hours, - -	2	27	33	29,9
☉'s mean Longitude sought -	0	18	2	41,9

differing only 0″,1 from the Ayanansa.

Example XI.

A. C. 4850, A. D. 1748.

The same for the 4850th year of the Cali yug (A. D. 1748).

Ayanansa and Longitude 18° 44′ 6″ a Bissextile year.

The formula being the same in all such cases, we have m = 46; ma = 46×4s 24v,04 = 3g 22v 25p,8; and E+ma = — 3g 24v 1p,88. Hence

	Ayanansa and Longitude.			
1748				
1702	Table XXXV,	18°	44′	6″
—	do. XXXVI,	18	44	32
46 = m.			—	26

and the time answering to 26″ is 10′ 35″ = dx.

		G.	V.	P.	
β = March	29	11	40	0	
+ 1 -	+ 1				
	30	11	40	0	
— E + ma -	—	3	34	2	
Equated Hindu time	30	8	15	58	
do. European time	30	3h	13′	23″	
— H -	—	6			
	29	21	13	23	p. m.
— L -	—	4	54	12	
	29	16	24	11	p. m.
— dx -		—	10	35	
Equated time, Meridian of Paris, T = March	29	16	13	36	

and the ☉'s mean Longitude for that time by Table LII, will be found 18° 44′ 6″,8.

The eleven preceding Examples provide for every possible case that can be proposed for any time past or to come; but there remains to shew the derivation of the various formulæ hitherto used, from the general one given at page 250, and this will be done by means of three Propositions, which are only introduced here for the sake of demonstration, their object being to trace the time when the terms S and a of the formulæ become equal to zero.

Section VI.

Proposition A.

The Equation for the beginning of A. C. 5602 is 1g 26v 40p = △ A. D. 2500 the Epoch referred to.

" If to the time of the beginning of the 5602d year of the Cali yug, answering to A. D. 2500, " you add 1g 26v 40p (34′ 40″ European time) = △, and reduce the same to noon under the " Meridian of Paris, the Sun's Longitude due to that instant, as given by the European Tables,

" will be equal to the Ayananse for that year as computed by the Hindu rule." (Proposition I.)

PROOF.

The beginning of A. C. 5602 as elicited by the rule given at page 8 of this collection, falls on Wednesday at $43^{g}\ 20^{v}\ 0^{p}$ after Sun rise at Lanca, and for the monthly date of the initial feria, we have by Tables V and VI, parts 1, Wednesday, 4th April, Julian style, therefore

Formula $T = \beta + SnC + \Delta + ma - dx$, where $SnC = 0$; $ma = 0$.

A. C. 5602, A. D. 2500.

Ayanansa and Longitude.

	s	°	′	″	‴
Table XXXV,	1	0	0	54	0
do. XXXVI,	1	0	1	35	41
Difference			—	41	41

41″,6

Answering to 16′ 52″ in time = dx.

		G.	V.	P.
$\beta =$ April	4	43	20	0
$\Delta =$	+	1	26	40
Hindu time	4	44	46	40
		H.	′	″
	4	17	54	40 from ⊙ rising.
— H -	—	6		
	4	11	54	40 p. m.
— L -	—	4	54	12
	4	7	0	28
		—	16	53
Time equated to Meridian of Paris, T = April	4	6	43	35 p. m.

For the Sun's mean Longitude according to the European Tables, we have (the year being a *leap* one),

Longitude and Ayanansa 1s. 0° 0′ 54″

	s.	°	′	″
Table LII, ⊙'s mean Longitude 1st January 2000 -	9	23	15	38
do. for 500 years - - -		3	49	38,3
⊙'s mean Longitude 1st January A. D. 2500 - -	9	27	5	16,3
By the same Table, part 2, for $94^{d}\ 6^{h}\ 43'\ 35''$ - -	3	2	55	37,5
⊙'s mean Longitude equal to Ayananse - -	1	0	0	53,8

differing only by 0″,2 from that produced by the Hindu rule.

PROPOSITION B.

" If to the foregoing constant Equation $1^{g}\ 26^{v}\ 40^{p} = \Delta$, you add the value of S ($7^{g}\ 20^{v}\ 4^{p}$) " for each century ascending from A. C. 5602, and to the sum you add the time of commencement of the current Tamul year, the Sun's Longitude due to the time so equated will be equal " to the Ayanansa." (Proposition I).

PROOF.

Let the commencement of the 5102^{d} year of the Cali yug, answering to the Julian Secular year 2000, be proposed. Then by the present Proposition, SnC + Δ = E.

		G.	V.	P.
from 5602	where nC according to former notation = 5, and S =	7	20	4
subtract 5102	nC		×	5
remains (5)00		36	40	20
To which add proposed Equation Δ	+	1	26	40
Equation due to A. Cal. 5102 = E		38	7	0

A. C. 5102, A. D. 2000.

The beginning of the 5102d year of the Cali yug, as we have seen at page 258, Example IV, is

		G.	V.	P.	
March	31	22	55	0	
Add Equation above found E =	+	38	7	0	
Hindu time, April	1	1	2	0	
		H.	′	″	
European time	1	0	21	43	from ☉ rising.
— H	—	6			
March	31	18	21	48	p. m.
— L		4	51	12	
	31	13	30	36	
— dx		—	12	15	
T″ = March	31	13	18	21	p. m

For the term dx, see Example IV, where it is equal to — 31″,6, answering to 12′ 15′ of time.

Ayanansa and Longitude 22° 30′ 54″.

and this result being precisely the same as that found at Example IV, needs no further verification.

		G.	V.	P.
It will readily be perceived that the Equation E		38	7	0
Is the complement of SnC+B		21	53	0
To a complete day	1ᵈ	0	0	0

E always referrible to +SnC+A or —SnC+B of the former formulæ.

So that when in Example IV we added 1 day and subtracted 21ᴳ 53ᵛ, we did precisely the same thing as in the present operation, when we added at once the said difference.

And in the same manner, if the 3102ᵈ year
of the Cali yug were proposed, 5602

nC would be equal to (25)00

		G.	V.	P.
and SnC – S		7	20	4
nC			×	25
SnC =	3ᵈ	3	21	40
To which add Δ =		1	26	40
Equation E	3	4	48	20

General for all years ascending from A. C. 5602, A. D. 2500.

which is precisely the same as was found at Example III, page 257, = 1ᵈ+SnC+A, and therefore requires no further illustration.

Thus it was that we found the formula

$$T = \beta + SnC + \Delta + ma \pm dx$$

given at page 250, of the expounding of which I shall give another Example.

EXAMPLE XII.

Let the 4804th year of the Cali yug (A. D. 1702) be proposed.

A. C. 4804, A. D. 1702.

2500
1702
———
(7)98

Then nC = 7. m = 98. SuC = $7^s\ 20^v\ 4^p \times 7$ = $51^g\ 20^v\ 28^p$, and ma = $98 \times 4^v\ 24^p,04$, = $7^g\ 11^v\ 15^p,9$.

Therefore

		G.	V.	P.
SuC	=	51	20	28
△	=	1	26	40
ma	=	7	11	15,9
SuC + △ + ma	=	59	58	23,9

which is the same Equation as that which was used at Example XI, page 264, and therefore the rest of the operation need not be performed.

Lastly, we are to determine the precise time when S and a will become = 0, on which occasion we shall observe, that as this Epoch probably *falls on a broken period of the year to which it refers*, the term a, which is the variation for one whole year, will exceed that which may be due to the commencement of the Solar year in the course of which it vanishes; a must therefore be transformed into $\frac{a \times D}{365}$, where D represents any number of odd days expired of the year.

Transformation of a for broken periods of years into $\frac{a \times D}{365}$.

PROPOSITION C.

The precise time when S and a are equal to 0, falls on the 15th December A. D. 2519, Julian style, (20th Gregorian style), at 18h 53′ 14″ p. m. under the Meridian of Paris, or $253^d\ 18^g\ 17^v\ 17^p$ after the commencement of the Hindu Solar year 5621 of the Cali yug, at Lanca.

Resolution of the Epoch when S and a = 0.

As the value of $\underline{m\ a}$ on the beginning of the Solar year 5602 (A. D. 2500) was found to be $1^g\ 26^v\ 40^p$, the time when it will be equal to zero is determined by this expression $\frac{1^g\ 26^v\ 40^p}{4^v\ 24^p,04}$ = 19 years, $253^d\ 18^g\ 17^v\ 17^p$, and as we have now only a *fraction of* a *on the beginning of the Hindu year*, the formula will become $T = \beta + \frac{a \times D}{365} - dx$, where D = 253 days in the present case, to expound which we have by Tables VII and I,

Special formula where $\frac{a \times D}{365}$ is *positive.*

		D.	G.	V.	P.
Initial root for the year C. 5602		(0)	38	13	45

which accounts for 19 years. And for the fraction $253^d\ 18^g\ 17^v\ 17^p$, the Supplementary Table LII, part 2, shews that there are 246 days expired at the end of *Margasiras*: taking therefore the collective root for the said time out of Table III, we have

		D.	G.	V.	P.
out of Table III, we have	(*)	(1)	13	37	10
Initial root of the month *Paushia*		(0)	56	50	55
To which add root for $7^d\ 18^g\ 17^v\ 17^p$	(+)	(0)	18	17	17
Root at the given instant		(1) Monday.	15	8	12

Margasiras.		253
	Table LII	246
Paushia		7th

which *feria* being expounded by means of the Dominical Letter E, Julian style, (Tables V and VI) will be found to fall on the 15th December A. D. 2519.

Here it is to be observed that we have added to the commencement of the Hindu Solar years, the two following fractions of roots, viz. -

		G.	V.	P.
	(*)	18	37	10
	(†)	18	17	17
Sum, Hindu time		36	54	27
do. European time		14h	45′	47″ (‡)

during which time the Sun's mean motion amounts to 36′ 21″,7. (‡) which are to be taken into the account when we compute the Sun's place by means of the Ayanansa; which by

	s.	°	′	″
Table XXXV =	1	0	18	0
XXXVI =	1	0	18	42

Difference 42 answering to 7′ 4″ of time = dx.

As for $\frac{a\,D}{365}$ we have 365d : 4v 24p,01 :: 253d (by Prop.) : 3v 3p.

OPERATION.

		G.	V.	P.	
β = December	15	15	8	12	
$\frac{a \times D}{365}$ (253d)		+	3	3	
Equated Hindu time	15	15	11	5	
do. European time	15	6h	4′	30″	☉ rising.
— H -	—	6			
	15	0	4	30	p. m.
— L -	—	4	54	12	
	14	19	10	18	
— dx -		—	17	4	
Equated time, Meridian of Paris, T =	14	18	53	14	p. m.

For the Sun's mean Tropical Longitude.

By the European and Hindu Solar Tables.

Ayanansa.

	s.	°	′	″
1st Vaisácha A. C. 5621,	1	0	18	0
200 days, Table LII, -	6	17	7	46
50 do. -	1	19	16	56,5
3 do. -		2	57	25,0
do. for 14h 45′ 47″ (‡) -			36	21,7
Sun's mean place	9	10	16	29,2

Table LII.

	s.	°	′	″
Sun's mean Longitude 31st Dec. 2519,	9	26	29	38,7
do. 348d or 14th December 2519 -	11	13	0	13,0
18 hours - - -			41	21,2
53 minutes - - -			2	10,6
14 seconds - - -				6
	9	10	16	29,1

The difference of which results is insensible.

There remains now only to shew, that S and a will change Signs from the 14th December 2519 Julian style, which will be proved by the following results.

Epoch when S and a change Signs.

Let the beginning of the 5622d year of the Cali yug (A. D. 2520 a *Bissextile*) be equated.

A. C. 5622, A. D. 2520.

The formula will be $T = \beta - \frac{a \times D}{365} - dx$, where D represents the number of days that remained from the 14th December 2519 to the end of the Hindu Solar year 5621, for which observing that this expression in the last Example was

Special formula where $\frac{a \times D}{365}$ is negative.

		V.	P.
observing that this expression in the last Example was -	$\frac{a \times D}{365}$ (253d) =	3	3
If you subtract the same from a - -	=	4	24,04
You have $\frac{a \times D}{365}$ (118d) its value for the present case -	=	1	21,04

Ayanansa, 1st Vaisácha, Cali yug 5622.

	s.	°	'	"
Table XXXV,	1	0	18	54
do. XXXVI,	1	0	19	36
Difference				42,

dx therefore remains as before = 17′ 4″.

Ayanansa and Longitude is, 0° 18′ 54″.

OPERATION.

Initial root, preceding Example.

	D.	G.	V.	P.
1st Vaisácha, A. C. 5621 - - -	(6)	38	13	45
Add for one year, Table I, - -	(1)	15	31	15
Initial root, 1st Vaisácha, A. C. 5622 -	(0)	53	45	0
	Sunday.			

which expounded in the usual manner with the Dominical Letters DC, shews that the initial feria *Sunday*, falls on the 4th of April 2520 Julian style. Therefore

		G.	V.	P.	
$\beta =$ April	4	53	45	0	
$- \frac{a \times D}{365} =$		—	1	21	
Hindu time	4	53	43	39	
European time	4	21	29	27,6	⊙ rising.
— H -		6			
	4	15	29	27,6	p. m.
— L -		4	54	12	
	4	10	35	15,6	
— dx -			17	4	
Equated time, Meridian of Paris, T = April	4	10	18	11,6	p. m.

And for the Sun's mean Longitude at the equated time by the European Tables.

	s.	°	'	"
⊙'s mean Longitude 1st January A. D. 2520 -	9	27	14	27,4
⊙'s motion for 94 days (on account of Bissextile) or 4th April by Delalande's Tables, - -	3	2	39	3
10 hours - -			24	38,5
18 minutes - -				44,4
11 seconds -				4
Sun's mean Longitude on the beginning of A. C. 5622 =	1	0	18	53,7

which differs only by 0″,3 from the Ayanansa due to that instant.

Thus we have proved by the result of many operations, the correctness of the formula $T = \beta \pm (SnC + m\,a) \pm dx$, given at page 250. An analytical demonstration of the same would no doubt have been more scientific; but it was observed by a learned Gentleman, to whose judgment this paper was submitted, that as the *Kala Sankalita* was principally intended for the instruction and use of persons little versed in the higher branches of the Mathematics, Examples were the best mode of demonstration; and to his opinion we have submitted our own. There remains now to shew the application of our formulæ to the resolution of questions, which depend on the Sun's position in the Hindu Sydereal Ecliptic, at a given instant of time, which to resolve by other means would involve the computer into long and delicate calculations.

FIRST CASE. (*)

Vestiges of the date of an old Inscription expounded.

A. C. 3614 under the government of N. Sun's apparent Sydereal Longitude ♏ $4^{\circ}\ 29'\ 47''$.

On an old Inscription much defaced by time, there remains no other vestiges of the date of the event which it was designed to commemorate, but that of the current year 3614 of the Cali yug, with the name of the year of Jupiter's cycle corresponding thereto, viz. *Calayucta* (the 52d), both answering to the 465th year Saca, or from the birth of Salivahana, and the name of the Prince N, who reigned at that time; and lastly, the Sun's apparent Longitude in the Hindu Sydereal Ecliptic on the day of the event, which is stated to have then been in $4^{\circ}\ 29'\ 47''$ of the Solar Sign Vrischica ♏.—Q. What was the Hindu Solar Sydereal date answering to that position of the Sun, and also the concurrent European date?

As the Sun's Longitude recorded on all public monuments is generally his apparent one, the first operation consists in deducing the *mean* from the apparent Sydereal Longitude proposed, being that to which the formulæ answer; and this is to be effected by means of several of the Tables contained in this collection, and by the following process.

The Christian year is expounded in the usual manner, 3614 — 3102 = 512 Julian Kalendar, and as the Sign Vrischica ♏ is the 8th of the Solar Sydereal Ecliptic, our Longitude is to be expressed $7^{s}\ 4^{\circ}\ 29'\ 47''$.

To deduce the Sun's mean from his apparent Longitude.

In order to deduce approximatively the Sun's mean from his apparent Longitude, we shall first use the latter as if it were his mean place for finding the corresponding Anomalistic Equation, which will be done by means of Tables XXII or XXIV, and XXVII, part 2d.

As the latter Table supposes the Sun's Apogee in $2^{s}\ 17^{\circ}\ 17'\ 20''$, which will be its place at the end of the 4910th year of the Cali yug, and as we want it for the 3614th, we are to correct the Apogee for 1297 years, for which (its motion being 1′ in 517 years), say $517^{y} : 60'' :: 1297^{y} : 2'\ 30''$ the Equation sought: which being additive in the 1st and 3d Quadrants, and subtractive in the 2d and 4th Quadrants of Anomaly (agreeably to the construction of Table XXVII), is in the present case to be subtracted.

(*) The date of the Inscription is assumed.

Now the Sign Vrischica ♏ answers to the Solar month Margasiras (Tamul Cartiga), on the first day of which the Sun's distance from his Perigee is (Table XXVII, part 2)

	s.	°	'	"
is (Table XXVII, part 2)	1	17	17	20
Subtract correction		—	2	30
Distance from do. 1st Margasiras	1	17	14	50

The Argument of the Sun's Anomaly.

But as by the Inscription the Sun was advanced 4° 29′ 47″ in the Sign Vrischica ♏, and because he is advancing towards his Perigee, that Arc is to be subtracted from the above

	s.	°	'	"
	1	17	14	50
the above	—	4	29	47
Sun's distance from Perigee, called *Manda Kendra*	1	12	45	3

which is the Argument of his Equation; therefore, with 1ˢ 12° 45′ 3″ referring to either Tables XXII or XXIV, we find the same to be 1° 29′ 20″; and because in Table XXVII, the negative Sign (—) is affixed to the month *Margasiras* when the apparent Longitude is sought, it is to be added in the contrary case. Hence

Sun's mean Sydereal Longitude 7s. 5° 59′ 8″.

	s.	°	'	"
Proposed apparent Longitude	7	4	29	47
Ravi Phala	+	1	29	20
☉'s approximate mean place	7	5	59	8

With which in such matters, one might very well be contented: but if more accuracy were required, as this mean Longitude would give an apparent one 2′ 34″ too great; on a second trial, which need not be exhibited, the exact mean Longitude sought would be found to be 7ˢ 5° 56′ 37″.

Sun's mean Sydereal Longitude assumed 7s. 6°.

In order to simplify what remains to be shewn in this Example, I shall suppose that the mean Longitude deduced from the apparent one was in round numbers 7ˢ 6°, which is of no consequence, since the difference in the Sun's motion falls considerably below an entire day.

Ayanansa + 38′ 42″

Sun's Hindu mean Tropical Longitude 7s. 6° 38′ 42″.

If we compute the Ayanansa due to the commencement of the 3644th year of the Cali yug, either by the rule exhibited at page 84, or by Table XXXV, it will be found = 38′ 42″

☉'s *Madhyama Graha*, as above	7ˢ	6°	0	0
Madhyama Ravi Sayana	7	6	38	42

or mean Hindu Tropical Longitude, deduced from Proposition, the error of which we are to calculate before we can determine the European date of the recorded event.

The beginning of the Hindu Solar year expounded into its corresponding European date.

For the time of commencement of the 3644th year of the Cali yug.

	D.	G.	V.	P.
By Table VII, Epoch A. D. 500	(0)	37	11	15
Table I, for 40 years	(1)	20	50	0
Do. 2 do.	(1)	15	31	15
Initial root sought	(3)	13	32	30

Soota dina *Wednesday*.

19th March A. D. 542.

For expounding this feria, if we proceed as indicated at page 23 and the following, and by help of Tables V and VI, we shall find that the Dominical Letter for A. D. 542 is E, and by the limits given in Table V, part 1st, that the Wednesday under consideration falls on the 19th March: with this we have the necessary data for correcting the Sun's Hindu Longitude.

Expounding the time of beginning of the year for finding the error of the Hindu Longitude.

OPERATION.

1700	
542	nC = 11. m = 58. SnC = 1d 20g 40v 44p. ma = 4g 15v 14p.
— (11)58	A = 7v 12p, and SnC+A+ma = 1d 25g 3v 10p.

Formula $T = \beta + 1^d + (SnC + A + ma) - dx$ (Prop. II.)

Ayanansa and Longitude.

	′	″
Table XXXV,	38	42
do. XXXVI,	38	42,8
Difference	—	0,8

answering to 20″ of time = dx.

	G.	V.	P.	
β = March	19	13	32	30	
1 day+SnC+A+ma =	2	25	3	10	
in Hindu time	21	38	35	40	
in European time	21	15	26	16	from ⊙ rising
— H -	—	6			
	21	9	26	16	p. m.
— L -	—	4	54	12	
	21	4	32	4	
— dx -			—	20	
Equated time, Meridian of Paris, T = March	21	4	31	44	p. m.

When the Sun's mean Longitude by the European Tables will be found as follows:

	s.	°	′	″
⊙'s mean Longitude 31st December 541 -	9	11	36	26,2
⊙'s motion for 80 days, by Table LII, or Delalande's, 21st March - -	2	18	51	6,4
do. 4 hours - - - -			9	51,4
do. 31 minutes - - - -			1	16,4
do. 44 seconds - - - -				1,8
⊙'s mean Longitude sought -	0	0	38	42,2

differing only from the Ayanansa above found by 0″,2.

Error of the Hindu Longitude in time 2d 10h 0 56″, in degrees 2° 22′ 57″,5.

Now by the Hindu Kalendar, the Sun is supposed to have entered ♈ on the 18th March A. D. 542, at $23^h\ 25'$ p. m. (1º); but according to the European Tables, that Longitude was only due on the 21st of the same month at $9^h\ 25'\ 56''$ p. m. also at Lanca (2º), the error of the Hindu Tables is therefore $2^d\ 10^h\ 0'\ 56''$; during which time the Sun would move through 2° 22′ 57″,5 of his Orbit, by which Arc

	G.	V.	P.		
1º March	19	13	32	30	from ⊙ rising
	—	15			
Hindu time -	18	58	32	30	
	18	23′	25′	0″	p. m.
		H.	′	″	
2º March	21	4	31	44	p. m.
	+	4	54	12	
	21	9	25	56	p. m.
	18	23	25	0	
Error in time -	2	10	0	56	
do. in degrees -	2°	22′	57″,5		

the Hindu Tables make his Tropical Longitude too great, as well as the Ayanansa, at the beginning of the year.

From this it results that if from the Hindu Tropical Longitude found at page 271 - - - - s. ° ′ ″ 7 6 38 42,0

We subtract the error - - - - 2 22 57,5

We have the corrected Longitude - 7 4 15 44,5

Corrected Tropical Longitude 7s. 4° 15′ 44″,5.

Expound by the Tables the time due thereto, viz. 31st December 541 - - - - s. ° ′ ″ 9 11 36 26,2

9 21 45 5,7 October 23d.

51 12,6 22 hours.

7 4 15 44,5

we have for the true date the 23d October 22^{h} 0′ 0″.

N. B.—We would have obtained the same result if after having expounded the Hindu Tropical Longitude by the Tables, which would have given October - 26 8^{h} 0′ 56″

True European date Meridian of Paris October 23d, 22h.

We had subtracted therefrom the error in time - 2 10 0 56

For there remains the same time as before found, October 23 22 0 0

True time.

Now this time referred to the Meridian of Lanca, and to that of Sun rising, expressed in Hindu guddias, &c. is - - October 23 22^{h} 0′ 0″ p. m. Paris.

H - 6

L - 4 54 12

European time - 24 8 54 12 from ⊙ rising.

True date expressed in Indian guddias, &c. October 24 22 15 30 at Lanca.

For the Hindu Solar monthly date.

Lastly, as the 1st Vaisácha A. Cali. 3644, fell on the 19th March 542 (page 272) we have from that date to the 24th October - - - - - - 219 days.

For the Hindu Solar monthly date.

But by the subsidiary Table LII, part 2, from the 1st Vaisácha to the last day in Cartica there are - - - - - - 216

There remains in the following month - 3

4th Margasiras current.

which are the number of days expired in *Márgasiras*. The current Hindu Solar date is therefore Márgasiras 4th, at 22′ 15′ 30″ after Sunrise at Lanca. (*)

(*) Although I have endeavoured to render this Example as clear as possible, yet as from the novelty of the process, a proof may be required that the result is exact, I shall expound by the usual formula the date now

Note.

To restore a lost Epoch.

The name of the year of Jupiter's Cycle being given, how to expound the numeral of the corresponding one of the Cali yug.

If it so happens that the numeral of the year of the Cali yug 3644, be also obliterated, so that there only remains the name of Jupiter's year, *Calayucta* the 52d of the Cycle of 60 years, we are to enquire how the Epoch may be restored, and for this we are to attend to the following considerations.

In Bengal they follow the Sastra account; in the Peninsula, that of the Tellingas.

The first point to be ascertained is in what part of India the inscription was found; for if in Bengal, the Chacra year will have been computed by the rule of the Surriah Siddhanta, modified by the Tika; and if in the Peninsula, by that of the Tellingas. In the present case we shall suppose that the inscription was found in Bengal.

The reign of the Prince whose name is recorded on any document affords data for the same when known in history.

We are now to observe that as there is a year of the same name in every Cycle of 60 years, the problem cannot be resolved unless some new data be furnished; but we may find a sufficient one in the name of the Prince or ruler who governed at the time of the recorded event, which is always inserted in the inscription, grant, perwana, &c. that is to be expounded; provided such a Prince or chief be known to Indian history. The time of his birth, of his ascending the throne, and of his death, or the end of his reign, are the limits to be most depended upon. In default of these, the Epoch of some memorable event which may have occurred during his reign, or that of any of his known cotemporaries, or even the time about which he flourished, may be considered as data, more or less to be depended upon, according to their degree of precision.

Or that of any of his known cotemporaries.

When the duration of any reign exceeds 60 years, the question is subject to two answers.

For although it be not impossible that the same individual should have possessed authority during sixty years of his life (in which case the question would be subject to two answers), yet as the contrary case is the most probable, there can be, in most cases, no very great fear of error when supposing any common reign to have lasted less than that number of years.

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obtained; which if it be correct should give the Hindu Tropical mean Longitude deduced from the apparent one found on the Inscription, viz. 7s. 6° 38′ 42″, (page 271).

Formula T = β + 1 + δnC + A + ma − dx, (Prop. II.)

N. B.—As the value of the terms has been computed at page 251, the same quantities are to be used.

For Sun's Longitude.

	s.	°	′	″
31st-December 541 -	9	11	36	26,2
October 26th -	9	24	42	30,7
8h. -			19	42,3
0′ 56″ -				2,3
Longitude sought -	7	6	38	42,0

		g.	v.	p.
β = October	21	22	15	30
1 day + δnC + A + ma =	2	25	3	10
	26	47	18	40
	26	18	55	28
− H - -		− 6		
	26	12	55	28
− L - -		− 4	54	12
	26	8	1	16
− dx - -				− 20
T =	26	8	0	56

which is the same as above.

EXAMPLE I.

Example according to the account of the Sastras.

Let it be supposed that N, the Prince whose name appears on the face of the inscription, is known in history; and that he reigned in Bengal between the years of the Cali yug 3601 and 3651: the first step to be taken is, to expound the year of the Chacra which corresponds to the first of these two Epochs; and this will be effected by means of the rule given in the Postscript to the third Memoir, and Table XVIII.

By the said Table it appears, that the last expunged year of the Chacra before the year 3601 of the Cali yug, fell in the 3581st year of the same; answering to A. D. 480

but 3601 current, or 3600 complete, answers to A. D. 499

difference 19

therefore we shall have 28 to add at the end of the rule. (*) To proceed,

1°.

86)3600(41
160
86
—
74

2°.

3600
+ 41
—
60)3641(60
41
+ 28
—
9 Yuva,

therefore Yuva, the 9th of the Chacra, answers to the 3601st year of the Cali yug current; but from Yuva 9th to Calayucta the 52d, there are 43 years; hence 3601 + 43 = 3644, the same year as that originally found on the inscription.

EXAMPLE II.

Example according to the Tellinga account.

Let us suppose that a *perwana* was granted by Sevajee, the chief and founder of the Marrahta power, which was dated, among other designations no longer legible, *Vicari*, the 33d year of the Chacra.

As Sevajee reigned in the Peninsula of India, the proposed Chacra year was no doubt computed according to the Tellinga account; and to expound it we are to refer to the appropriate rule, disclosed in the third Memoir, and adverted to at page 148 of this work; the process of which is still more simple than the former.

Now as we know that *Sevajee* died in the 4782d year of the Cali yug (4781 complete), answering to A. D. 1680, find the Chacra year corresponding thereto.

60)4781(79
581
41
+ 13
—
54 *Raudra*, the current year by the Tellinga account.

(*) Vide Postscript to the 3d Memoir, page 213.

But *Vicari* is the 33d of the Chacra, and as the Epoch which we have expounded is that of Sevajee's *death*, it is manifest that the year sought is that which preceded *Raudra*, the 54th; hence 54 — 33 = 21 years to be subtracted from 4782: we have therefore A. Cal. 4761, answering to A. D. 1659, for the Epoch which corresponds to the proposed *Vicari*, and which needs no further demonstration.

The Epoch being thus recovered, the Ayanansa may be computed, and the process for expounding any particular date of the same, (as shewn in the first part of this article) will apply.

The Ayanansa an unerring data for recovering a lost Epoch.

Lastly, it sometimes happens (though not in inscriptions, perwanas, nor grants; but in Astronomical documents) that the Ayanansa remains among the Elements which have been preserved, although the numeral of the year has been lost. This case admits of a ready and unerring solution, by means of Table XXXV, which in all cases will restore the Epoch, as must be well known to the reader.

SECOND CASE.

The date of an ancient Solar Eclipse expounded into Hindu Solar time.

The most ancient Eclipse which has been transmitted to us by the Babylonians, occurred on the 19th March A. A. Christum 720; at 6h 45′ p. m. Meridian of Paris.—Wanted the concurring Hindu Epoch of the same Eclipse under the Meridian of Lanca; together with the error of the Hindu Solar Tables at that time.

CAUTION.

A. A. C. 720, 6h 45′ p. m. Meridian of Paris.

1º The year 720 before Christ is a Bissextile one; therefore for finding its Dominical Letters, we are to use the first part of Table VI.

2º And because the proposed year ascends before the birth of Christ, for finding the commencement of *the corresponding* Solar Sydereal year, we are to use the third part of Table V.

A. Cali yug 2382 current.

3º The notation of the year of the Cali yug will be 3102 — 720 = 2382; and as it preceded the institution of the æras Vicramaditya, and Salivahana, it cannot be expressed in the same.

4º By Table V, part 3, as the 2302d and 2402d years of the Cali yug began on the 7th March, there can be no doubt but that the proposed year commenced very near to the same date in its own month of March.

OPERATION.

For the time of beginning of the Hindu Solar year.

For the commencement of the 2382d year of the Cali yug, answering to A. A. C. 720.

	D.	G.	V.	P.
By Table VIII, part 2d, Initial Root, A. 700 B. C. -	(0)	56	40	0
For 20 years, by Table I, subtract - -	(4)	10	25	0
Initial Root of A. Cali yug 2382 -	(3)	46	15	0

Soota dina, Wednesday.

To expound this feria into its European date, we find by Table V, part 3, that the Secular Christian year before Christ 700, began on a *Thursday*; and by Table VI, part 1st (the year being a Bissextile one) that 4 days are to be *subtracted* from the said Thursday in order to obtain the feria on which that year began, which falls therefore on a *Sunday*: hence the Dominical Letters sought are AG.

7th March A. A. C. 720.

Now, as the date falls in March, with G as the Dominical Letter, refer to the Kalendar about the 7th of that month, and you will find that Wednesday (the Soota dina) falls on the 7th of March.

But the proposed date is the 19th, therefore adding 12 days to the 1st Vaisácha, we have the 13th of that month current (the 12th complete) for the date of the Eclipse, and to have its precise time at *Lanca* according to Hindu reckoning, say,

	H.	′	″	
Time from noon at Paris - - -	6	48	0	p. m.
To count the time from Sun rising, add - -	6			
And to refer to the Meridian of Lanca - -	4	54	12	
Time of Eclipse counted from Sun rise, European Hours, &c.	17	42	12	
The same converted into Hindu guddias, viguddias, &c.	41^g	15′	12^p	after ⊙ rising.

Hindu Solar time of Eclipse at Lanca.

Answer.—The Hindu Solar date of the Eclipse which occurred on Monday the 19th March A. A. C. 720, at 6^h 48′ p. m. at Paris, would have been expected at Lanca on Monday the 13th Vaisácha of the 2382d year of the Cali yug, at 41^g 15′ 30^p after Sun rise.

* * *

For the error of the Hindu Solar Tables.

Let us now consider what would be the error in the Sun's mean Longitude at that time, according to the Hindu Tables.

I. We have seen that the month Vaisácha and year 2382 of the Cali yug began on Wednesday, at 46^g 15′ 0^p, after Sun rise at Lanca, when the Sun's Sydereal Longitude was supposed to be = 0.

Ayananssa — 18° 17′ 6″ mean Tropical Longitude of 1st point in the Sydereal Zodiac 11s. 11° 42′ 51″ Hindu account.

Now if we compute the Ayananssa for the beginning of the said year, it will be found = — 18° 17′ 6″.

	S.	°	′	″
The Sun's Tropical Longitude therefore was -	12	0	0	0
	—	18	17	6
⊙'s mean Tropical Longitude, 1st Vaisácha 2382 -	11	11	42	54

which day as we have seen, fell on the 7th March A. A. C. 720.

Time wanting to complete the 12th Sydereal day.

II. The Hindu Solar date of the Eclipse being the 13th Vaisácha (12th complete), the Sun's mean motion must be added to the above Longitude for that number of days.

	G.	V.	P.	
But the Sydereal month began at - -	46	15	0	after ⊙ rise.
And the time of Eclipse was - - -	44	15	20	
Difference -	1	59	30	

Tropical Sun's Longitude at the time of Eclipse according to the Hindu Kalendar 11s. 23° 30′ 37″.

which were wanting of the 12th Sydereal day *complete*, when the Eclipse was to occur; and during that time the Sun's mean motion was 1′ 57″,8 which quantity is therefore to be subtracted. Hence,

	s.	°	′	″
☉'s mean Longitude, 1st Vaisácha - -	11	11	42	54
His motion for 12 days - - -		11	49	40
	11	23	32	34
Deduct the same for the incomplete day -		—	1	57
Ravi Sayana, or Sun's Tropical Longitude - -	11	23	30	37

according to the Kalendar, but which is inconsistent with the existence of the Eclipse.

III. In order to find the error of the Hindu Tables, let the time for which it was predicted according to the Solar Kalendar, be equated by means of the formula given at page 253, Proposition II.

$$T = \beta + 1 + SnC + A + ma + dx.$$

OPERATION.

A. A. C. 720 nC = 24. m 20. SnC = 2ᵈ 56ᵍ 1ᵛ 36ᵖ. m a = 1ᵍ 28ᵛ 1ᵖ.
Epoch 1700 A = 7ᵛ 12ᵖ.

(24) 20

		D.	G.	V.	P.
SnC	=	2	56	1	36
+ A	=			7	12
+ m a	=		1	28	1
SnC + A + m a	=	2	57	36	49

Ayanansa.
Table XXXV, 18° 17′ 4″
do. XXXVI, 18 17 30

Difference 26 answering to 10′ 39″ of time = dx.

S = 7ᵍ 20ᵛ 4ᵖ
nC = × 24
SnC = 2ᵈ 56 1 36

a = 4 24,04
m = × 20
ma = 1 28 1

Hence

		G.	V.	P.	
β = March	19	44	15	30	
1 day + SnC + A + ma - -	3	57	36	49	
Equated Hindu time - -	23	41	52	19	
do. European time - -	23	16ʰ	44′	56″	from ☉ rising
— II - -	—	6			
	23	10	44	56	p. m.
— L - -	—	4	54	12	
	23	5	50	44	
+ dx - -		+	10	39	
Equated time, Meridian of Paris, T = March	23	6	1	23	p. m.

When the Sun's mean Longitude by Delalande's Tables, or Table LII, will be found to be as follows:

	S.	°	′	″
⊙'s mean Longitude, 1st January A. A. C. 720	9	2	26	25,0
⊙'s mean motion for 82 days, Table LII; or 23d March	2	20	49	23,1
Do. for 6 hours, 1′ 25″ do. part 2,			14	50,5
⊙'s mean Longitude sought	11	23	30	38,6

which differs only from that found by means of the Ayanansa, Article II, by 1″,6.

IV. Now since the Hindu Kalendar supposed that the Sun's Tropical Longitude on Monday, March the 19th, at 11^{h} 42′ 12″ p. m. at Lanca (1º), was 11^{s} 23° 30′ 38″, whereas it only reached that position on the 23d of the same month at 10^{h} 55′ 35″ (2º), it follows that the Kalendar was 3^{d} 23^{h} 13′ 23″ slow, (3^{d} 58^{g} 3^{v} 27^{p} Hindu time), during which time the Sun would more through 3° 54′ 38″,4, which shews the quantity by which the Hindu Tropical Longitude of the Sun (or the Supplement of the Arc of Ayanansa to 12^{s} at the beginning of the year) was *too great;* and consequently the Ayanansa too little.

(1º)

		G.	V.	P.	
Lanca, March	19	44	15	30	from ⊙ rising.
		— 15			
Hindu time	19	29	15	30	p. m.

(2º)

Paris, March	23	6	1	33	p. m.
Difference of Longitude	4	4	54	12	
Lanca	23	10	55	35	
	19	11	42	12	
Error in time	3^{d}	23^{h}	13′	23″	
in degrees	3°	54′	38″,4		

Error of the Hindu Solar Tables in time 3d. 23h. 13′ 23″, in degrees 3° 54′ 38″,4.

	S.	°	′	″
Hence from the Longitude found at Article II, page 278	11	23	30	38
Subtract error of Hindu Tables	—	3	54	33,4
⊙'s correct mean Tropical Longitude	11	19	35	59,6
	6			
At the time of Eclipse	5	19	35	59,6

⊙'s corrected mean Tropical Longitude 5s. 19° 35′ 59″,6.

To verify which

Compute the Sun's apparent Longitude answering to that above found.

		S.	°	′	″
⊙'s mean Longitude		5	19	35	59,6
Equation of the center			1	42	57,6
Nutation	— 2″,9				
♃'s Equation, 1st part					3,7
Do. do. 2d part	— 2,1				
	— 5,0				
♀'s Equation					1,2
☽'s do.					2,4
Subtract Nutation and 2d part		5	21	19	4,5
♃'s Equation				—	5,0
⊙'s apparent Longitude at time of Eclipse		5	21	18	59,5
The same computed by Dominique Cassini		5	21	27	0,0
Difference				8	0,5

Sun's apparent Longitude at the time of Eclipse.

No apology I conceive, need be offered for this difference of 8′ in the Sun's apparent Longitudes at the time of the Eclipse, considering that of the processes through which they have been respectively elicited, and the remoteness of the Epoch.

How to express the Sun's Sydereal Longitude according to Hindu account.

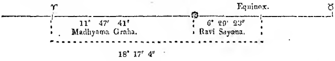
To find the Sun's position in the Hindu Sydereal Ecliptic, and his distance from the Equinoctial point at the time of the Eclipse consistently with the Hindu Solar Tables.

VI. Since according to the Indian computation by means of the Ayanansa, the Sun's mean Longitude on the 13th Vaisácha, at 11ʰ 42′ 12″ p. m. (Art. IV), was supposed to be

Sun's Madhyama Graha 11° 47′ 41″, Ravi Sayana 6° 29′ 23″ uncorrected.

	s.	°	′	″
(Art. II) - -	11	23	30	37
	12			
His distance to the Vernal Equinox was - - -		6	29	23
And as the Ayanansa for the beginning of that year was (Art. II)		18	17	4
His supposed place in the Sydereal Ecliptic should have been =		11	47	41

which will be better understood by referring to the Type.



CONCLUSION.

VII. It follows from this research, that if the Sun's mean Longitude had been rightly expressed in the Hindu Tables (even if no other cause had interfered, such as that of the time occurring during the night) the Eclipse could not have occurred at the predicted time; because that one should have been possible on the 13th of Vaisácha, the Sun's Longitude should have been 11ˢ 19° 36′ on that day at 44ᶢ 15ᵛ 30ᵖ after Sun rise at Lanca, as we have seen at Article V. But the feria or weekly day on which the European Catalogue states the Eclipse to have occurred, cannot be changed in consequence of any hypothesis in the error of the Hindu Kalendar, and since *Monday* the 19th March, is that indicated by the former, *Monday* the 13th Vaisácha (Tamul Chaitram) has been well expounded; from which it follows, that the error lies in the Hindu Solar Tables, and not in the Kalendar.

The error in the Hindu Solar Tables.

If therefore the Sun's Sydereal Longitude be proposed, and the Hindu Solar time be known, and if the Christian corresponding Epoch is to be deduced therefrom (which can only be done by referring the Sun's place in the Sydereal to the European Tropical Ecliptic) the proposed Sydereal Longitude must first be corrected.

Case where the Sun's apparent Longitude is found recorded on an Inscription.

For instance, let it be supposed that the Sun's apparent Longitude in the Sydereal Ecliptic 13° 30′ 41″ was found recorded on an inscription, with the year 2382 of the Cali yug, which reduced to his mean place would be 11° 47′ 41″ (Article VI), if we compute the Ayanansa for the beginning of the said year, it will be — 18° 17′ 4″ (Article III), and if we equate the time of beginning of that year, we shall find the error of the Hindu Tables to be 3° 54′ 33″,4 (Article IV), therefore

The converse of the preceding proposition.

		°	′	″
From the Sun's mean Longitude - - -		11	47	41
Subtract error - - - - -		3	54	38
Corrected Madhyama Graha - - -		7	53	3
Which subtract from Ayanansa - - -		18	17	4
Ravi Sayana or distance to Equinox - -		10	24	1
	12'	0	0	0
Sun's Tropical mean Longitude corrected -	11	19	35	59

And if we convert the same into time by reversing the process for using the Tables, it will be

	s.	°	′	″
Sun's mean Longitude 1st January A. A. C. 720 -	9	2	26·	25
70 days - -	2	8	59	43,1
8 do. - -		7	53	6,6
6 hours - -			14′	47,1
40 minutes - -			1	38,6
8 do. - -				19,4
Time expounded 19th March at 6^h 48′ p. m. -	11	19	36	0,1

which is the same as was originally proposed, within a trifling fraction of time, the latter Longitude being 1″ greater.

POSTSCRIPT.

I intended to have confined this paper to the preceding pages: but having communicated to a learned friend the following computations of the error of the Hindu Solar Tables, as derived from the Solar Kalendar at the end of each Quadrant of the Ayanansa, when taken in its fictitious form (such as it now obtains among Native Astronomers), he was of opinion that these should not be withheld, because if any modern *Jyautish Sastra* should ever be qualified to read this work, he would find therein a clear proof of the absurdity of the system to which they are all so generally attached. (*)

I shall therefore give the calculations of the place of the first point in the Hindu Sydereal Ecliptic, in the Tropical one at the end of each Padah of the Ayanansa, using the formulæ, an account of which was given in the body of this Appendix; and deduce the error of the place assigned to the Sun when in the said points by the Hindu Solar Sydereal Kalendar, in the manner that was adopted in the preceding Examples.

(*) See the Diagram at the top of page 247.

CASE 1.

To find the Tropical Longitude of the first point in the Hindu Sydereal Ecliptic at the end of the first Padah of the Ayanansa, which falls at the expiration of the 1800th year of the Cali yug, answering to A. A. C. 1301.

The formula for this case will be

$$T = \beta + \overset{\text{day}}{1} + (SnC + A + m\,a) + dx \text{ (Prop. II.)}$$

1301
1700
(30)01

where $nC = 30$. $S = 7^{s}\,20^{v}\,4^{p}$. $A = 7^{v}\,12^{p}$. $m = 1$.
$ma = 4^{v}\,24^{p},04$.

$SnC + A + ma = 8^{d}\,40^{g}\,13^{v}\,36^{p}$.

Ayanansa.	°	′	″
Table XXXV,	27	0	0
do. XXXVI,	27	0	37,5
			37,5

Tropical Longitude of ♈.

s.	°
12	0
	27
11	3

answering to 15′ 12ᵛ of time = dx.

And if we expound the time of commencement of the 1801st year of the Cali yug by the rules which were given in the Key to the Madhyama Saura mana, it will be found to fall on March the 3d, at $28^{g}\,38^{v}\,45^{p}$ after Sun rise, under the Meridian of Lanca = β.

OPERATION.

		d.	v.	p.	
β = March	3	28	38	45	from ☉ rise.
$1^{d} + SnC + A + ma =$ -		4	40	13	36
Sum in Hindu guddias, &c.	8	8	52	21	
do. in European hours, &c.	8	3	32	56,4	
— H	— 6				
	7	21	32	56,4	p. m.
— L	—	4	54	12	
	7	16	38	44,4	
+ dx		+	15	12	
Time equated, Meridian of Paris, T = March	7	16	53	56,4	p. m.

For the Sun's mean Longitude by the European Tables, at the equated instant of time.

	s.	°	′	″
By Table LII, ☉'s mean Longitude 31st December A. A. C. 1302 -	8	27	15	12,2
☉'s mean motion for 66 days, or March 7th - -	2	5	3	9,3
do. for 16 hours - -			39	25,5
50 minutes - -			2	3,2
3 do. - -				7,4
50 seconds - -				2,1
6 do. - -				2
☉'s mean Longitude at Equated time -	11	2	59	59,9
	12			
European Ayanansa - -	0	27	0	0,1

differing only 0″,1 from the Hindu Ayanansa.

For the error of the Hindu Solar Tables.

By the Hindu Kalendar the Sun is supposed to have entered the Sign ♈ on the 3d March A. A. C. 1301, at $5^h\ 27'\ 30''$ p. m. (1°), at Lanca; and the Sun's Longitude on the 7th of the same month was $11^s\ 2^\circ\ 59'\ 59'',9$ at $21^h\ 48'\ 8''$ p. m. also at Lanca. The error of the Hindu Tables was therefore $4^\circ\ 36'\ 49'',6$ in *plus*, which is to be subtracted from the Sun's mean Hindu Longitude in order to have the true one at the time referred to.

1°

		G.	V.	P.	
March	3	28	38	45	from ☉ rising
	—	15			
Remainder in Hindu guddias, &c. -	3	13	38	45	p. m.
do. in European hours	3	5^h	27′	30″	

2°

		H.	′	″	
Paris, March	7	16	53	56	p. m.
	+	4	54	12	
Lanca, -	7	21	48	8	p. m.
	3	5	27	30	
Error in time	4	16	20	38	
do. in degrees	4°	36′	49″,6		

CASE 2.

The same for the commencement of the 3601st year of the Cali yug, answering to A. D. 499, when the Ayanansa completed its second Padah. The formula being the same as in the preceding case. End of the second Quadrant.

$$\begin{array}{r} 1700 \\ 499 \\ \hline (12)01 \end{array} \qquad nC = 12. \qquad ma = 4^s\ 24^v,04. \qquad SnC + A + ma = 1^d\ 28^g\ 12^v\ 24^p.$$

Ayanansa and Longitude
by both Tables $= 0$; therefore $dx = 0$.

And expounding the time of commencement of the Hindu Solar year as usual, we have

		G.	V.	P.
β = March	19	6	8	45
1 day + SnC + A + ma = -		2 28	12	24
Sum, Hindu time -	21	34	21	2
	21	13	44	27,6
— H -	—	6		
	21	7	44	28
— L -	—	4	54	12
Equated time at Paris, T = March	21	2	50	15

For the Sun's mean Longitude by the European Tables.

	s.	°	′	″
Table LII, ☉'s mean Longitude 31st December A. D. 498 -	9	11	1	54,9
☉'s motion for 80 days or 21st March - -	2	18	51	6,4
do. for 2 hours - - -			4	55,7
50 minutes - - -			2	3,2
10 seconds - - -				4
5 do. - - - -				2
☉'s mean Longitude at Equated time =	0	0	0	0,8

differing only 0″,8 from the Hindu Ayanansa.

For the error of the Hindu Solar Tables.

By the Hindu Kalendar the Sun is supposed to have entered the Sign ♈ on the 18th March A. D. 499, at $20^{h}\ 27'\ 30''$ p. m. at Lanca (1°), and the Sun's Tropical Longitude was $0^{s}\ 0^{\circ}\ 0'\ 0''$ on the 21st March at $7^{h}\ 44'\ 27''$ p. m. also at Lanca, by the European Tables. The error of the Hindu Tables was therefore $2^{\circ}\ 26'\ 4'',8$ in *plus*, as in the foregoing case, and is therefore subtractive of his Hindu Longitude at the time referred to.

1°			G.	V.	P.	
	March	19	6	8	45	from ⊙ rising.
		—	15			
		18	51	8	45	
	March	18	20^{h}	$27'$	$30''$	p. m.
2°			H.	′	″	
	March	21	2	50	15	
		+	4	51	12	
		21	7	44	27	p. m.
		18	20	27	30	
Error in Hindu time		2^{d}	11^{h}	$16'$	$57''$	
do. in degrees .			2°	$26'$	$4'',8$	

CASE 3.

End of the third Quadrant. The same for the commencement of the Hindu Solar year 5401 of the Cali yug, answering to A. D. 2299, when the Ayanansa will complete its third Quadrant.

In this case the formula becomes

$$T = \beta + 1 - (SnC + B + ma) - dx.$$

2299	$nC = 4.$ $m = 99.$	$ma = 99 \times 4^{v}\ 24^{p},04 = 7^{g}\ 15^{v}\ 40^{p}.$
1800		
(4)99	$SnC + B + ma = 43^{g}\ 48^{v}\ 48^{p}.$	$B = 7^{g}\ 12^{v}\ 52^{p}.$

Ayanansa and Longitude.

	°	′	″
Table XXXV,	27	0	0
do. XXXVI,	27	0	37,5
Difference			37,5

answering to $15'\ 15'' = dx$.

And expounding the commencement of the Solar year as usual, we shall find

		G.	V.	P.
β = April	3	43	38	45
+ 1 day - -	1			
	4	43	38	45
$-SnC + B + ma$ = -	—	43	48	48
Remainder, Hindu Time -	3	59	49	57
do. in European hours -	3	23	55	58,6
— H	—	6		
	3	17	55	59
— L	—	4	54	12
	3	13	1	47
— dx		—	15	15
Equated time at Paris, T = April	3	12	46	32

For the Sun's Longitude in the Tropical Ecliptic by the European Tables.

	s.	°	'	"
By Table LII, ☉'s mean Longitude 31st December A. D. 2298 -	9	21	48	36,2
☉'s mean motion for 93 days, or 3d April - -	2	31	39	54,7
do. for 12 hours - - -			29	34,2
46 minutes - - -			1	53,4
32 seconds - - -				1,3
☉'s mean Longitude at Equated time -	0	26	59	59,8

differing only 0",2 from the Hindu Ayanansa.

For the error of the Hindu Tables.

By the Hindu Kalendar the Sun, it is supposed will enter Mesha ♈ on the 3d April, A. D. 2299, at 11h 27' 30" p. m. at Lanca; and the Sun's Longitude on the same day at 17h 40' 44" p. m. was 26' 59' 59",8 also at Lanca. The error of the Hindu Tables will therefore be 15' 19",7 in *plus*, and as in the preceding case, is to be subtracted from the Sun's mean Hindu Longitude at the time referred to.

			G.	V.	P.	
1°	April	3	43	38	45	from ☉ rise.
		—	15			
		3	28	38	45	
		3	11h	27'	30"	p. m.
			h.	'	"	
2°	Paris, April	3	12	46	32	
		+	4	54	12	
	Lanca, -	3	17	40	44	
		3	11	27	30	
	Error in time	0	6	13	14	
	do. in degrees			15'	19",7	

CASE 4.

The same for the commencement of the year 1 of the Cali yug, answering to A. A. C. 3101, and for that of A. Cal. 7201, answering to A. D. 4099, at both of which Epochs the Ayanansa is supposed by the Hindu Astronomers, to be in the beginning of its first Quadrant.

Beginning of the 1st and end of the 4th Quadrant.

These two cases are to be resolved by means of the formula exhibited at Propositions II and III respectively (page 253), the first being applicable to all years ascending from A. A. C. 1301 in the first Quadrant, and the second to those descending from A. D. 2299 to 4099 in the fourth Quadrant of the Ayanansa. (*) As both these Epochs are very remote, the reader may not be displeased to find here a last Example of the manner of expounding the beginnings of A. Cal. 1 and 7201.

FIRST EPOCH.

I.

1st Epoch, A. Cal. 1 A. A. C. 3101.

For the value of β in A. C. 1.

	D.	G.	V.	P.
By Table VIII, A. A. C. 3000 - - -	(3)	58	45	0
Table I, for 100 years, subtract - - —	(6)	52	5	0
	(4)	6	40	0
Do. for 1 year, subtract - - -	(1)	15	31	15
Initial Root, A. C. 1, sought - - -	(2)	51	8	45

Soota dina, Tuesday:

(*) Vide Diagram.

to expound which into its European date, we find by the Supplement to Table V, that the Dominical Letter for A. A. C. 3100, is AG, therefore that for 3101 is B; and by the Table itself, that the 102d year of the Cali yug, answering to 3000 years, begins on the 16th February.— But the commencement of the Hindu Solar years *anticipate only 9 days in 1000 ascending* years (vide Tables), therefore referring to any perpetual Kalendar with the Dominical Letter B, about the 16th of February, we find *Tuesday* the *Soota dina*, to fall on the 15th February. Hence the value of β in the formula is, February 15th, $51^g\ 8^v\ 45^p$. (*)

II.

Expounding now the formula $T = \beta + 1^{day} + (SnC + A + m\,a) + dx$, as usual, we have

3101 $nC = 48$. $m = 1$. $m\,a = 4^v\ 24^p,04$. $SnC + A + ma = 5^s\ 52^g\ 14^v\ 48^p$.
1700
——
(48) 01 $A = 7^v\ 12^p$.

Ayanansa.
Table XXXV, $1^s\ 24°\ 0'\ 0''$
do. XXXVI, 1 24 1 14
Difference 1 14
answering to $30'\ 20''$ of time = dx.
12
1 24 0
Longitude 10 6

		d.	v.	p.
β = February	15	51	8	45 from ☉ rise.
$+1^{day} + SnC + A + ma$ =	6	52	14	48
Hindu time -	22	48	23	33
European time -	22	17^h	$21'$	$25'',2$
— H -	—	6		
	22	11	21	25,2 p. m.
— L -	—	4	54	12
	22	6	27	13
+ dx -	+		30	20
Equated time, Meridian of Paris, T = February	22	6	57	33

For the Sun's mean Longitude according to the European Tables.

	s.	°	′	″
Table LII, ☉'s mean Longitude 31st December A. A. C. 3102 -	8	13	28	30,6
☉'s *mean motion for 53 days, or 22d February* - -	1	23	14	21,5
Do. 6 hours - - - -			14	47,1
57 minutes - - - -			2	20,4
33 seconds - - - -				1,3
☉'s mean Longitude at Equated time -	10 12	6	0	0,9
European Ayanansa - -	1	23	59	59,1

differing only from the Hindu Ayanansa by $0'',9$.

III.

Now this Supplement of the Sun's Longitude amounting to $1^s\ 23°\ 59'\ 59'',1$, or say $1^s\ 24°$, one

---

(*) The Cali yug is vulgarly supposed to begin on a *Friday*, but it is to be remembered that, in order to make its commencement fall with the beginning of the week, as it was then reckoned, a *Cshepa* of 2d. 8g. 51v. 15p was added to the *Ahargana*. (Vide Key to the Madhyama Saura Mana, page 10.)

half of which is 27°, shews that whereas the Tabular Ayanansa goes on increasing (and its Supplement decreasing) from A. A. C. 1301 to 3101, the *Epicircular one has a contrary progress;* so that whatever view ancient Astronomers may have taken of that Element at the time referred to, it is certain that their modern successors would equate it into + 27°—27° = 0.

In order to deduce the error in the Sun's mean position which would result from such a theory, we are not therefore to confine ourselves to a comparison of "what the Sun's Longitude is supposed to be and really is at the given instant at Lanca," as we have done hitherto; but we are also to account for 54° of Ayanansa, rejected by the absurd system of Libration, which *answer to 54ᵈ 13ʰ 52′ 22″ of time.*

IV.

For the error of the Tables.

Now by the preceding operation it appears that *by the Hindu Kalendar,* the Sun entered Mesha ♈ on the 15th February at 14ʰ 27′ 30″ p. m. at Lanca (1º), in A. A. C. 3101; and that the Sun's Tropical Longitude according to the European Tables was 10ˢ 6° on the 22d February at 11ʰ 51′ 45″ p. m. also at Lanca (2º), the first part of the error of the Hindu Tables is therefore 6° 47′ 34″,6, and the second 1ˢ 24°, amounting in all to 2ˢ 0° 47′ 34″,6 *in plus,* as before, by which the Hindu Astronomers of ancient times, (or rather some more recent speculator deceived at the time of observation by the effects of the Solar *Equation* and the nutation of the Earth's Axis, which he could not otherwise explain) would have mistaken the Sun's position relatively to the Equinoxes, at the commencement of the Cali yug; a supposition wholly untenable.

(1º)

		H.	′	″	
February	15	51	8	45	*from* ⊙ rise.
		— 15			
Hindu time	15	36	8	45	
February	15	14	27	30	p. m.

(2º)

		H.	′	″	
February	22	6	57	33	p. m.
+		4	54	12	
February	22	11	51	45	
	15	14	27	30	
Error in time	6	21	24	15	p. m.
do. in degrees		6°	47′	34″,6	
+	1ˢ	24	0	0	
Total error =	2	0	47	34,6	

Second Epoch.

I.

The same resolution for the beginning of the 7201st year of the Cali yug, answering to A. D. 4099. 2d Epoch, A. C. 7201, A. D. 4099.

The formula in this case is $T = \beta + 1 - (\mathrm{SnC} + \mathrm{B} + \mathrm{ma}) - \mathrm{dx}$.

Proceeding as usual for the value of β by means of Tables I and VII, we shall find the initial root for A. C. 7201, answering to A. D. 4099, to be

	D.	G.	V.	P.
	(0)	21	8	45
and the Soota dina - -			*Sunday.;*	

to expound which the Dominical Letter may be found as follows:

II.

The series in Table V, part 1, extends only to A. D. 2000; but that which we want, as it refers to the Julian Kalendar, may easily be deduced from that Table, by extending it to the given year; a process which hardly requires two minutes of time. In this manner the Dominical Letters for A. D. 4100 will be found to be CB, and that for the preceding year, now wanted, D.

For expounding the Soota dina, *Sunday*, into its European date, we find (arguing as we did in the preceding article) that in 2000 years descending, the beginning of the Hindu Solar year retards 17 days in the European corresponding Julian year. But in A. D. 2000 it begun on the 31st March; adding therefore 17 days thereto for the year concurring with A. D. 4000, and then adding again a day (nearly) for each century, we are sure to find the beginning of the 7201st of the Cali yug (A. D. 4099) about the 18th April.

Referring therefore to the Kalendar with the Dominical Letter D, we find that *Sunday*, the Soota dina, will fall on the 19th April A. D. 4099.

The value of β will accordingly be, April 19th, $21^g\ 8^v\ 45^p$.

III.

To expound the formula we have, therefore,

4099 $nC = 22.$ $m = 99.$ $m\,a = 99 \times 1^v\ 24^p{,}04 = 7^g\ 15^v\ 40^p.$
1800
$SnC + B + m\,a = 2^d\ 55^g\ 50^v\ 0^p.$ $B = 7^g\ 12^v\ 52^p.$
(22)99

Ayanansa and Longitude.

	s.	°	′	″
Table XXXV,	1	24	0	0
do. XXXVI,	1	24	1	14
Difference			1	14

answering as before to 30′ 20″ of time = dx.

		G.	V.	P.
β = April	19	21	8	45
+ 1 day - +	1			
	20	21	8	45
$-SnC+B+ma$ - —	2	55	50	0
Remainder, Hindu time	17	25	18	45
Do. European time	17	10	7	30
— H - —		6		
	17	4	7	30
— L - —		4	54	12
	16	23	13	18
— dx - —			30	20
Equated time, Meridian of Paris, T = April	16	22	42	58

For the Sun's mean Longitude by the European Tables at the Equated time.

IV.

	s.	°	′	″
By Table LII, Sun's mean Longitude 31st December 4098, -	10	8	35	17,9
Sun's mean motion for 106 days, or 16th April -	3	14	28	43,0
22 hours - -			54	12,6
42 minutes -			1	43,5
58 seconds - -				2,4
Sun's mean Longitude at Equated time	1	23	59	59,4

differing only by 0″,6 from the Hindu Ayanansa.

For the error of the Hindu Tables.

By the Hindu Kalendar the Sun is supposed to enter Mesha ♈ on the 19th April at 2^h 27′ 30″ p. m. A. D. 4099, at Lanca, and the Sun's Tropical Longitude was found 1ˢ 24° according to the European Tables on the 17th April at 3^h 37′ 10″ p. m. also at Lanca.

1°			G.	V.	P.	
	April	19	21	8	45	from ⊙ rising
		—	15			
		19	6	8	45	
	April	19	2	27′	30″	p. m.
2°			H.	′	″	
	April	16	22	42	58	p. m.
		+	4	54	12	
	April	17	3	37	10	
		19	2	27	30	
Error in time -		1	22	50	20	
in degrees		1°	55′		24″,9	
Error of Ayanansa		1ˢ	24	0	0	
Total error -		1	25	55	24,9	

Now as the Ayanansa goes on increasing in the Tables with a contrary Sign from that which it had at the preceding Epoch, whereas according to the Libratory doctrine it decreases from A. D. 2299 *descending* until in A. D. 4099, when it becomes equal to zero, making the Ayanansa 54° equal to + 27° — 27° = 0, it follows that the error of the Tables deduced from this operation amounts to 1° 55′ 24″,9 in its first part in *minus*, and consequently is to be added to the mean Hindu Longitude; and in the second to 1ˢ 24° also in *minus*, therefore the whole error is 1ˢ 25° 55′ 24″,9, which was to be determined.

END OF APPENDIX II.

APPENDIX III.

TRACT ON CHRONOLOGY,

With directions for referring dates recorded in any of the three
principal HINDU STYLES, *to corresponding ones of any*
æras registered in the annexed CHRONOLOGICAL
TABLE *: with an account of the ancient*
and modern Jewish years.

APPENDIX III.

A Sketch of some of the principal Æras and Periods of ancient times, referred to in Chronology; with directions for finding the corresponding years in each of them, to any year proposed according to the Hindu styles of the Cali yug, Vicramaditya, *and* Salivahana.

In publishing this short tract, which merely consists of extracts from books on Chronology, I am far from imagining that I present any thing new to the attention of the learned reader: but the experience of thirty years in India has taught me, that let works on such topics be ever so common in Europe, they are seldom, and in many cases, no where to be found when wanted in this part of the world.

If any thing could excuse an Indian author for having failed in point of accurate reference, or presented under the garb of novelty, a piece of information which may perhaps be found in every library in England, it would certainly be the penury of books on the sciences here complained of. Indeed it has come to my personal knowledge in another path of research (independently of the origin of the third Memoir of this collection), that the greatest Geometer that came to India since the days of Mr. Robins, (*) was frequently reduced, in order not to interrupt a work which will transmit his name to posterity, to analyze Problems, and construct Tables, which had been resolved and constructed more than a century before his time.

To return to our subject, I thought that my task would remain incomplete if, after having explored the principal Hindu doctrines which relate to time, I were not to furnish some means for referring them to accounts probably equally ancient, and certainly much better known to the generality of readers. I trust, therefore, that the present endeavour to collect in a small compass a few of the leading features of ancient Chronology, will not be deemed (at least by my Indian readers) a useless increase of this volume.

EXTRACTS, &c.

The words Æra and Epoch generally mean the same thing in Chronology. Sometimes however, *Epoch* is specially used to designate the particular time of an event, without reference to any Æra: we find it also employed in the sense of the beginning of an Æra.

(*) The late Lieut. Colonel William Lambton, Superintendent of the Grand Trigonometrical Survey of India, to whom the author was, during several years, an assistant. It is also related of the late Mr. Andrew Scott, that whilst in the Northern Circars, and wanting a Table of Logarithms, he found no shorter way to procure one, than to construct it himself.

In order to reduce the various accounts of time which have been used by mankind to a common scale, a period of years was invented which, commencing before all known Epochs, involves them all. Such is the *Julian* period, invented by Joseph Julius Scaliger about the middle of the XVIth century.

The Julian period. Of the *Julian period.*—This period is a series of 7980 years, arising from the multiplication of the Cycles of the Sun, Moon and Indiction; or of the numbers 28, 19, 15; its Epoch commencing on the 1st day of January of the 706th year before the Creation. The Julian period therefore, is not yet completed.

As every year of that period has its particular Solar, Lunar, and Indiction Cycles; and as no two years in it can have all these three Cycles the same, any year that can be proposed is accurately distinguished from all the rest.

We shall postpone the application of this and following observations to our purposes, until after an account of the most useful Æras has been laid before the reader.

Solar Cycle. 2. The *Solar* Cycle.—A period of 28 years, beginning with 1 and ending with 28.

Metonic or Lunar Cycle. 3. The *Metonic* or Lunar Cycle.—A period of 19 years. It only holds true for $310\frac{7}{10}$ years, because on every 19th year the Moon returns near an hour and a half sooner, which error in $310\frac{7}{10}$ years, amounts to an entire day.

Indiction. 4. Cycle of *Indiction.*—A period of 15 years revolving like others, and commencing (by anticipation) 3 years before A. D. 0 complete; or 1 current of the Dyonisian account: So that if 3 be added to any proposed year of Christ, and the sum be divided by 15, the remainder (neglecting the quotient) marks the year of Indiction. The first Indiction was settled and agreed upon in A. D. 313.

Mundane Æra. 5. The *Mundane* Æra, or Epoch of the Creation of the World.—The best authors of Port Royal, in whose number was the celebrated Pascal, and Le Maitre de Saci, place that event 4004 years before the vulgar or Dyonisian Æra. The Jews however, made it 243 years later, or A. A. C. 3761, which is still the Epoch of their Mundane Æra. (*)

Cali yug. 6. The *Cali yug* of the Indians.—A period of 432000 years, of which 3101 had expired on the 14th March A. D. 1 current. It is taken to have begun on Friday, the 18th February.

Æra of Nabonassaar. 7. Æra of *Nabonassaar*, first King of the Chaldeans or Babylonians.—Its Epoch is taken to fall on Wednesday, 26th February A. A. C. 747. Its year was of 365 days, without any intercalation on the 4th.

Olympiads. 8. *Olympiads.*—A period of 4 years, the first of which began (it is supposed) with the nearest New Moon to the Summer Solstice A. A. C. 776, being the 3938th year of the Julian period, and 24 years before the foundation of Rome. The best Chronologists have computed that, the 1st year of the 195th Olympiad coincided with the 1st year of Incarnation, consequently

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(*) Vide Note at the end of this Appendix.

i, See note on page 81, [illegible]

the 5th year of Christ answers to the 1st of the 196th Olympiad. The Olympiadic years began with the Summer Solstice, or rather on the 1st July, so that the six first months of any year of Incarnation answer to one year of the Olympiad, and the six last to another.—The last of these periods was the 404th; and corresponded to A. D. 440.

Indian Æra of Vicramaditya.

9. Indian *Vicramaditya*.—An Indian Prince who is supposed to have ascended the throne 57 years before Christ. In the northern parts of India, instead of numbering their Luni-solar years from the beginning of the Cali yug, the Natives count them from the accession of Vicramaditya. This denomination however, makes no difference in the construction of the Luni-solar year.

Cezarian of Antioch.

10. *Cezarian* of *Antioch*.—An Epoch established by the inhabitants of that town, in commemoration of Cezar's victory at Pharsalia, A. A. C. 47. The Syrians made it begin in the month of August, or on the 9th Sextilis of that year (as it was then called), in which the Greeks differed: the latter fixing it on their month *Gorpiæus* of the preceding year 705 of Rome, or A. A. C. 48, being the Epoch most generally used.

Iberian or Spanish.

11. *Iberian* or *Spanish*.—This Æra, which is grounded on the Julian Kalendar, owes its rise to the conquest of Spain, which was achieved by Augustus in the year 715 of Rome, but its fictitious Epoch dates from the 39th year before Christ, beginning with the 1st January of the ensuing year. This Æra was long used in Spain, Africa, and the Southern Provinces of France, and was finally abolished in A. D. 1415.

Indian Grahaparivrithi.

12. Indian period *Gruhuparivrithi*, of 90 Solar years, used in the Southern Provinces of the Peninsula of India.—It is stated to be constructed of the sum of the products in days of 15 revolutions of Mars, 22 of Mercury, 11 of Jupiter, 5 of Venus, 29 of Saturn, and 1 of the Sun. Its Epoch is A. A. C. 24. Its years vary by a few hours.

Æra of Constantinople.

13. Of *Constantinople*.—In that period the first year of Incarnation falls in 5509, and answers to the last year of the 195th Olympiad.—This account subsisted as long as the Greek Empire, and the Russians preserved it until the reign of Peter the great. The years of this Æra are either Civil or Ecclesiastical, the first begins with the 1st September; the second sometimes on the 21st March, and at others on the first April.

Of Alexandria.

14. Of *Alexandria*.—The first year of the Incarnation answers to the 5503d of that period. It was followed by several of the General Councils, and used in some of the most ancient computations. Like the preceding account, it is supposed to refer to the Creation of the World, but assigning a different Epoch to that event from other accounts.

The *Mundane* Æra, called that of the Greeks, is the same as that of Alexandria.

Ecclesiastical of Antioch.

15. *Ecclesiastical* of *Antioch*.—The 1st year of the Incarnation was taken to correspond to the 5493d of that period; retarding the Epoch of the Creation by 10 years more than the Alexandrian account.

Indian Vrihaspati Chacra.

16. The Indian *Vrihaspati Chacra*, or Cycle of 60 of Jupiter's years.—This Cycle is constructed on the hypothesis that a revolution of the Planet Jupiter, is equal to 12 of its own years, and consequently 5 revolutions to 60 *Vrihaspati* years.—These kind of years (if they ever were) are no longer used as an immediate measure of time; but as each of these bears a specific name, they serve for giving a particular designation to every Solar and Luni-solar year during its scope of 60 years, after which the series begins anew in the same order. In the Northern Provinces of India, when Astronomers compute the succession of these years, they refer still to the revolutions of the Planet; in consequence of which, one year is expunged every 86th Solar year.—But the Tellinga Astronomers make no difference between the *Vrihaspati*, and Solar years, and consequently expunge nothing; so that their years correspond to a different point of the Cycle, or Chacra, and bear a different name.

213.

The year *current* of the Chacra on the first year of the Christian Æra, was *Sadharana*, the 44th of the 53d Cycle (vide Postscript to the third Memoir.)

Of the Seleucidæ.

17. Of the *Seleucidæ*, of which there are two.—These periods are also called of the *Syro-Macedonians*, because they originated with the successors of Alexander the great.

The first.

The first Æra of the Seleucidæ takes its rise from the death of Alexander, i. e. A. A. C. 323. It was little used.

The second.

The second has its Epoch 12 years later, and therefore dates 311 before Christ. It answers to the year of Rome 442, and its years are *Julian*. This Æra has been much in use among the nations of the Levant, and is still followed by the Catholics of Syria. The Jews, after their subjection to the Kings of Syria, adopted it, giving it the name of *Tarik-Dilcarnaim* (the Æra of Bargains), because they used it in their commercial transactions.

The Æra of the Seleucidæ, is still in use among the Arabs. *Alfragan* made its year begin on the 1st September, but *Albategni* on the 1st October.

Indian Æra of Salivahana.

18. Indian Æra of *Salivahana*.—The name of a Prince supposed to be born 78 years after Christ, and a descendant of Vicramaditya, of which some account is given at article 9.—This Æra serves to number the Solar years by a shorter account than from the Cali yug; in the same manner as the Æra Vicramaditya is used for the Luni-solar years. The Solar years expressed from the birth of *Salivahana* are called *Saca*.

Its years called Saca.

Æra of the Martyrs.

19. Of Dioclesian or the Martyrs.—This Æra owes its rise to the elevation of that Emperor to the throne. It is called of the Martyrs, on account of his persecution of the Christians. Its Epoch is A. D. 284, and its year begins on the 29th of August. The Æra of Dioclesian is still used by the Copths and Ethiopians.

Of the Hejira.

20. Of the Hejira.—An Æra followed by the Mahommedans all over the world: its years are Lunar, and of 354 and 355 days, as they are common or intercalaries. It has a Cycle of 30 years,

eleven of which are always of 355 days. Its Epoch is the 16th July 622, but according to most Arabian Astronomers the 15th of the same month.

The two Persian

21. The two Persian Æras.—1º That of *Yezdegird* III, King of Persia. 2º That of *Maleck Shaw Dgelal-ul-deen*, Sultaun of *Korassaun*.

The Yezdegirdic.

The *Yezdegirdic.*—The Epoch of this Æra refers to the accession of that Prince, which took place on the 16th June A. D. 632; ten years after that of the Hejira. The years of this Æra were vague and of 365 days, and the months of 30; but at the end of the month *Aben* it was customary to add 5 days; which intercalations the Astronomers only introduced at the end of the year. This style was followed in Persia until it was reformed, and superseded by,

The Dgelalean.

The *Dgelalean.*—*Maleck Shaw Dgelal-ul-deen* reformed the *Yezdegirdic* Kalendar in the year of Christ 1079. Having assembled a council of eight Astronomers for that purpose, they determined that the Vernal Equinox should be fixed on the 14th of March. They maintained the 5 intercalary days or *Epagomenes* which the *Yezdegirdic* had borrowed from the Egyptian year, but during 6 or 7 periods of four years (*) they found it necessary to introduce a sixth *Epagomen*, as an incidental Equation, after which periods the intercalation of the 6th day would only take place every five years.

The Persian Tropical year consists of $365^{d}\ 4^{h}\ 49'\ 15''\ 0'''\ 48''''$, which period brings back the Equinoxes and the Solstices on the same days of the year, better than the Gregorian revolutions.

The *Dgelalean*, or *Mulalean* style (as it is sometimes called) is still in use in Persia. Although it be not noticed in the Table of Epochs inserted in this article, it may be useful to find here the names of the Persian months and days.

The Months.

1	Asrudia, or Aphrudin-meh,
2	Ardihasht, or Ardisasht-meh,
3	Cardi-meh,
4	Thir-meh,
5	Merded, or Mordad-meh,
6	Shirbirrir-meh,
7	Mehar-meh,
8	Aben-meh,
9	Adar-meh,
10	Di-meh,
11	Behen-meh,
12	Affirer, or Assirer-meh.

The 5 Epagomenes in the common, and the 6, in the redundant years, are called *Musteraca.*

The Persians do not divide the month into weeks, like other nations, but they give to each day a specific name.

Names of the days.

1	Hormozd,
2	Behman,
3	Ardabshesht,
4	Sharivar,
5	Esphendarmod,
6	Khordad,
7	Mordad,
8	Dibadur,
9	Azur,
10	Aben,
11	Khour,
12	Mah,
13	Tir,
14	Dghioush,
15	Dihameher,
16	Meher,
17	Souroush,
18	Resh, or Roush,
19	Fevardin,
20	Beheram,
21	Ram,
22	Bod,
23	Dibadin,
24	Din,
25	Erd,
26	Ashtad,
27	Osman,
28	Ramiad,
29	Marasfend,
30	Aniran.
	Musteraca, or *Epagomenes.*
1	Ahnoud,
2	Ashnoud,
3	Esphendarmer,
4	Vahest,
5	Heshounesh.

(*) I can find in no book which of the two numbers was used.

Æra of Parasurama.

22. Æra of *Parasurama.*—An account of time used in that part of the Peninsula of India called *Malayala* by the natives; extending from Mangalore, through the Provinces of Malabar, Cotiote, and Travancore, to Cape Comorin. It derives its name from a Prince who is supposed to have lived in the year 1176 before Christ, and who was a great encourager of Astronomy.

Dr. Buchanan states that the inhabitants of Malayala reckon time in Cycles of 1000 years from that Epoch; and that their year begins when the Sun enters the Sign Canya ♍ (Virgo): answering to the Hindu Solar month Aswina (Tamul Paratasi); and furthermore, that in September A. D. 1800 there were two Cycles and 976 years expired of that Æra, the year commencing, being the 977th of the 3d Cycle.

As the Christian year 1800 answers to the 4902d of the Cali yug, and 1723 from the birth of Salivahana current; and as by these accounts, which represent the same year, the new year began on Thursday the 10th of April (see General Table I), it follows that the Sun will have entered Canya ♍ on Sunday the 14th of September ensuing. (Page 11, and Table III).

The concurrence is therefore as follows:

The commencement of the 977th year of the 3d Cycle of Parasurama, answers to the 1st Aswina (Tamul Paratasi) of the 4902d year of the Cali yug or 1723 Saca; and to the 14th September A. D. 1800.

From what has been stated it also results, that the number of years of the *Æra of Parasurama* expired on the birth of Christ, are 1176, and that the 1177th began on the 1st of Aswina A. Cm. 3102, answering to the 17th of August A. D. 1, Julian style. (Tables V, 2d part, and VII).

And lastly, that the Epoch fell on the 7th August of the year 3537 of the Julian period, answering to the 1925th of the Cali yug.

Æra of the ancient Jews.

23. *The ancient Jewish Æra.*—Although the two Æras of the Jews, and the Luni-solar year of the Ancients (as given by *Montucla* in his History of the Mathematics, without mentioning the name of the nation which used it) are not included in the Table here annexed, yet as there are many Jewish tribes under the Bombay Presidency, who may be supposed to reckon time according to either, and as both are very little known to Europeans in this part of India, I conceive that some mention of these styles is not foreign to the object of this paper.

Of the ancient Æra I have not been able to collect any very distinct account; I understand that it is never referred to by Chronologists, but for times before Christ; what follows will therefore be sufficient for the present purpose.

That Æra was composed of Lunar years, reckoned from the Creation, which the ancient, as well as modern, Jews place 3761 years before the birth of Christ. The year was of 12

Lunar months, but originally fitted to the Solar one, by adding 11 and sometimes 12 days at the end of the year; but when it assumed a more regular shape, it became embolismic, and subject to a 13th Lunar month. The series of these intercalations, however, I find expressed no where; but is probably the same as that of the modern Jews. In intercalary years, the month *Adar* was repeated, being of 29 days in common, called defective; and of 30 in embolismic, called redundant.

Again in the defective, *Cisleu* was only of 29 days, and in the redundant *Marshervam*, was of 30.

The names of the ancient months were the same as the modern ones, the only difference being that the old Jewish style begins the year with *Nisan*, and ends it with *Adar*; whereas the modern begins it with *Thisri*, and ends it with *Elul*. The ancient Jews made much use of the Æra of Nabonassaar, of which some account has been already given; and their Luni-solar year is still the Ecclesiastical one in present times; at least as far as regards the season when it begins and ends.

A distinction to be made between the Indian, and Jewish years of both styles is, that the embolismic months of the former may fall on any of the five long Solar months of the year, whereas those of the latter invariably fall on the month of *Adar*.

Mundane Æra of the Jews, also called the modern.

21. *Of the Mundane Æra of the Jews, also called the modern.*—This Æra is likewise composed of Lunar years of 12 and 13 months, the intercalations falling on the 3d, 6th, 8th, 11th, 14th, 17th and 19th of the Metonian Cycle. The modern Jews pretend that its institution dates from high antiquity, but most Chronologists affirm that it was unknown before the XIVth century, although some say that it is to be traced up to the XIth. In this account of time, the whole expired duration of the Æra is divided into Cycles of 19 years, and of these 198 had elapsed on the birth of Christ; the last of which ended in the autumn of the first Christian year.

The Lunar months of the Mundane Æra, which bear the same names as those of the ancient one, are alternately of 30 and 29 days: they are reckoned like those of the Hejira, to begin on the first appearance of the Moon after the conjunction.

We have already observed that the modern year begins with the month *Thisri*, instead of that of *Nisan*, i. e. 6 months later. In embolismic years the month *Adar* is likewise repeated, but the name of the second Adar is changed into that of *Ve Adar*, and in the order of the Kalendar, is the 7th of the year; so that *Nisan* becomes the 8th, Jiar, or Islar, the 9th, and so forth to *Elul*, which (in the supposed case) is the 13th.

Civil year of the Jews.

The *Civil* year of the Jews begins with the new Moon of September, and the *Ecclesiastical* with that of March; the former following the new, the latter the old Kalendar.

Both common and embolismic years, distinguished into deficient, mean, and redundant.

Independently of the modern year being distinguished between common and embolismic, each of these distinctions is also subdivided into three sorts, viz. the deficient, the mean, and the redundant, or superabundant.

Discarded or unlawful days of the Jews.

In order to understand how the Jews determine practically these different species of years, it is necessary to know that they have certain *discarded* days, on which it is not permitted to celebrate the great festivals of the year, such as *Easter-day*, the *Tabernacles*, and *Pentecost*, or Whit-sunday; for when these happen to fall in the common course of time, on any of the unlawful days, they are respectively transferred to the next lawful one. These contingencies are ruled by the following two precepts, expressed in a few Latin words.

1º Nunquam *Nisan* in Badu.

2º Nunquam *Thisri* in Adu.

Badu expressing the numbers, 2, 4 and 6, and *Adu* 1, 4 and 6, the prohibited feriæ or weekly days.

The *Kebies* or lawful days.

Should therefore the new Moon of *Nisan* fall on the 2d, 4th or 6th feria, its observance is forbidden on those days, lest Easter-day, which is always kept on the 15th of that Moon, should fall on an unlawful day; those on which the Ecclesiastical year is permitted to begin, being called *Kebies*.

Rosh Ashana, the name of the beginning of the Jewish year.

From the same conception of unlawful days, the rule directs that there should be no observance of the new Moon of *Thisri*, which marks the beginning of the *Civil* year (called *Rosh Ashana)* when it falls on the 1st, 4th or 6th feria of the week; for in such a case the festival of the *Tabernacles* cannot be celebrated as usual, and as Whit-sunday, or *Pentecost*, is the 50th day after Easter, and must consequently fall on the feria next to that of Easter, the holy day alluded to is not to be kept on either the 3d, 5th or 7th day of the week.

How to find which is a deficient, mean or redundant year.

When the lawful day or *Kebie* on which the year is to begin, has been determined, the Jews find whether it be a common, or an intercalary year, and at the same time (whichever of these it may prove) whether it be a deficient, mean, or redundant one, of its sort, in the following manner.

PRECEPT 1.

Precept for a common year.

"Subtract the Kebie of the proposed year from that of the following one, and if the latter be "less than, or equal to the former, add 7 days thereto: and if the remainder be 3, 4 or 5, the "current year is a common one. Furthermore, it is deficient, mean, or redundant, as these "numbers are increasing from 3 to 5.

PRECEPT 2.

Precept for an embolismic year.

"But if the remainder be 5, 6 or 7, then the proposed year is embolismic. Moreover, it is "deficient, mean, or superabundant, as these numbers are increasing from 5 to 7."

N. B.—The three sorts of years of each kind, consist of the following number of days.

Duration of each.

Of the common,—the deficient is 353^d; the mean 354^d; the redundant 355 days.

Of the embolismic,—the deficient is 383^d; the mean 384^d; the redundant 385 days.

EXAMPLE 1.

Examples.

Let the *Kebie* of any proposed year be 3, and that of the following one 7; if we subtract the former from the latter, the remainder will be 4: which, according to the preceding rule, shews that the given year is a *common* one; and of *that sort*, a *mean year*. Examples.

EXAMPLE 2.

But if the Kebie of the proposed year be 5, and that of the ensuing one also 5; then 5+7=12; and 12 — 5 = 7, which shews that the current year is *embolismic*, and also a *redundant* year.

Q. E. I.

Table exhibiting the names of the Jewish months, and the duration of each sort of years and months, whether deficient, mean, or redundant.

	Common Jewish years.							Embolismic years.			
		Years.							Years.		
	Names of Jewish months.	Deficient.	Mean.	Redundant.	Corresponding Julian months.			Names of Jewish months.	Deficient.	Mean.	Redundant.
		Days.	Days.	Days.					Days	Days.	Days.
1	Nisan, or Abib	30	30	30	March	April	1	Nisan	30	30	30
2	Jiar, Islar, or Zius	29	29	29	April	May	2	Jiar	29	29	29
3	Sieban, or Sievan	30	30	30	May	June	3	Sieban	30	30	30
4	Thamuz	29	29	29	June	July	4	Thamuz	29	29	29
5	Ab	30	30	30	July	August	5	Ab	30	30	30
6	Elul	29	29	29	August	Septem.	6	Elul	29	29	29
7	Thisri, or Ethanim	30	30	30	September	October	7	Thisri	30	30	30
8	Marshesvam, or Bul	29	29	30	October	Novem.	8	Marshesvam	29	29	30
9	Cisleu, or Casleu	29	30	30	November	Decem.	9	Cisleu	29	30	30
10	Thebeth	29	29	29	December	January	10	Thebeth	29	29	29
11	Shebeth, or Saabath	30	30	30	January	February	11	Saabath	30	30	30
12	Adar	29	29	29	February	March	12	Adar	30	30	30
					March		13	Ve Adar (inter.)	29	29	29
	Sums of days -	353	354	355							
					Sums of days -				383	384	385

25. *Luni-solar year of the Ancients.*—*Montucla*, from whose History of the Mathematics the present article was extracted, has omitted to state in what country, and what people made use of this year, which he calls merely " *Of the Ancients*". His account of it is as follows: Luni-solar year of the Ancients.

That year is grounded on a Cycle of 19 years, like that of *Meton*. Its mean duration is 354^d 8^h 43′ 38″ $11'''$,988, &c. The Cycle was divided into 12 complete, and 7 incomplete years, which last they intercalated, so that their embolismic months fell on the 3d, 6th, 8th, 11th, 14th, 17th, and 19th of the Cycle, being the same in order as that of the Jews, and invariably followed through the ensuing Cycles, both differing from the method of the Indians, according to which the Epochs of intercalations are variable.

Again, as the Ancients found that 99 Lunar months (of 29^d 12^h 43′ 38″ $10'''$,99, &c.) contained 2923 days and 12 hours, which in 60 years gave an excess over the Sun's mean motion of 3 days; and 30 in 160 years, they omitted at the end of that period, *one* of the intercalary months. The Luni-solar year of the Indians has in appearance a similar omission; but it must not be supposed to have the least analogy with the expunged month of the Ancients, 1° Because the *Cshaya* of the

Indians is not confined to 160 years, but may recur after 141 and 19 years; 2º Because, whereas the Ancients *really* retrenched one month, the Indians omitted *nothing*; the supposed Equation bearing entirely on the artificial duration of the year, the names and succession of their months.

The Chaldean Saros or Sossos.

26. The Chaldean Saros, or Sossos.—Of this Æra I shall only observe that although some Gentlemen have fancied that it might have some affinity with the Cycle of Jupiter of 60 years, yet we hardly know more of it than its name. Halley considered it to be the period of 223 Lunar months, used at the time of, and even before Hypparchus, for computing the return of Solar Eclipses. But Delalande affirms, that it was a mistake which originated with *Saidus*, and is now entirely abandoned.

CHRONOLOGICAL TABLE.

Concurrence of Chronological Epochs at the birth of Christ, and Epochs of subsequent events referred to A. D. 0 complete.

After Christ.	Reform of the Kalendar in England 29th March 1752.	1752
	Gregorian reformation of the Kalendar 4th October 1582.	1582
	Æra of Dioclesian or of the Martyrs, year begins 29th August.	286
	Indian Æra of Salivahana, begins with the Hindu Solar year.	78
	Indiction.	3
	Epoch of the Indian Cycle of 90 years or Grahaparivrithi, begins with the Hindu Solar year.	24
	Iberian or Spanish, its year begins with the Julian year.	38
	Cezarian of Antioch, year begins in August.	48
	Indian Æra of Vicramaditya, begins with the Hindu Luni-solar year.	57
	2d of the Seleucidæ, year begins 1st September, but according to the Arabs 1st October.	312
	Æra of Nabonassar, began 26th Feb.	746
	Building of Rome, or Roman Æra.	752
	Olympiads, year begins 1st July.	776
	Indian Æra of Parasurama, begins 7th August 3537 of the Julian period.	1176
	Indian Æra of the Cali yug, begins Friday 18th February 1612, Julian period.	3101
Referred to supposed Epoch of Creation.	Epoch of Creation according to Port Royal writers.	4004
	Epoch of Creation according to Hutton.	4007
	Julian period.	4713
	Ecclesiastical of Antioch.	5492
	Æra of Alexandria.	5502
	Æra of Constantinople, begins *Civil* 1st September, *Ecclesiastical* 21st March.	5508
	Year of Christ complete, according to Dyonisius Exiguus.	0

For Epochs before Christ.

For Epochs after Christ.

Application of the Chronological Table.

By means of this Table any year proposed according to either of the Indian accounts, may be referred to the corresponding one of any other Æra therein registered.

For let the proposed year be expressed according to the style of the Æras *Cali yug*, *Vicramaditya*, or *Salivahana*; the same may be reduced to Christian account by adding 3101 to the first, 57 to the second, and by subtracting 78 from the third.

Having thus found the Christian year answering to that proposed in any of the three principal Indian accounts, if you want the concurring one of any other Æra, the Epoch of which ascends to any period before Christ, you have the following Precept.

PRECEPT 1.

" To the year of Christ, found as above
" directed, *add* that given in the Table for
" the Æra referred to, and the sum will
" give the year sought."

For Epochs which fall after Christ.

PRECEPT 2.

1º If the Æra in which the year is sought begins *before* Christ.

When the Epoch falls before Christ and the year sought after.

" To the proposed Indian year, *add* its proper Epoch, the sum gives the Christian year ; and " to the latter *add* the Epoch of the Æra sought, the sum gives the corresponding year (in that " Æra) to the proposed Indian year."

When both fall after Christ.

2° If the Æra, the year of which is sought, as well as the proposed one, begins *after* Christ.

" To the proposed Indian year, *add* its proper Epoch, and from the sum, *subtract* that of the " Æra sought, the remainder gives the year in the same, which answers to the proposed one."

EXAMPLE I.

Examples.

Let the year 4923 of the Cali yug complete, be proposed.—Wanted the year of the Julian period corresponding thereto?

Year of the Cali yug into that of the Julian period.

$$\begin{array}{lr}
\text{By Precept we have} & 4923 \\
 & -\ 3101 \\
 & \overline{1822} \\
 & +\ 4713 \\
\text{Year of the Julian period sought} & \overline{6535}
\end{array}$$

EXAMPLE II.

Let the year Vicramaditya 1879 be proposed : then $1879 - 57 + 4713 = 6535$, the same as in the first Example ; whence we conclude that the year of the Julian period 6535 answers to the end of the 4923d year of the Cali yug, and the 1879th of Vicramaditya.

EXAMPLE III.

Year of Salivahana into the same.

Let the same be proposed for the year 1744 from the birth of Salivahana. Then by Precept, $1744 + 78 + 4713 = 6535$ of the Julian period.

But if instead of the corresponding year of the Julian period, we required that of the Æra of the Martyrs, the Epoch of which is 286 years *after* the year of Incarnation 0 ; we shall have by Precept $1744 + 78 - 286 = 1536$, the corresponding year of the Æra sought.

The converse of these rules is so evident, that it requires no Examples ; all that need be added is, that on the above principles, the years of the Cali yug 4923, of Vicramaditya 1879, and Saca 1744, will be found to answer to years of different Æras, as follows :

The Hindu year referred to different Epochs.

To that of Constantinople	7330
of Alexandria	7321
Ecclesiastical of Antioch	7314
of the Julian period	6535
of the World	5826
of Nabonassar	2568
of the Iberian	1860
of the Martyrs	1536
&c.	

Æras subject to Cycles.

There remains to consider the Indian Æras which are subject to Cycles, such as the *Grahaparivrithi* of 90 years, and *Vrihaspati* of 60 years.

As the former are merely Solar years, as well as the latter, when computed according to the Tellinga account, the process for finding the mere abstract concurring years is the same as that above explained. But if we consider these when expressed by a specific name, or by cycles and years, the case no longer applies. Thus if we want merely the year of the Grahaparivrithi which

The Grahaparivritti, or Cycle of 90 years.

expired in A. D. 1822, we need only add 24 thereto, and it will be 1846, so that referring to Examples I and II, the year of the Julian period corresponding thereto will be 6535, as before.

But if the number of cycles and years expired be given, which would be found by $\frac{1822+24}{90} = 20$ cycles, 46 years complete, or $21^c\ 47^y$ current, that expression must be decomposed before referring it to any year of another Æra.

The Vrihaspati or Cycle of 60 years.

According to the Tellingas.

In the same manner the years of the Vrihaspati Chacra, by the *Tellinga* account, are always presented either by names or numerals; and the Chacra year corresponding to A. D. 1822, would be elicited by $60)4923(82^c\ 3^y$ expired; and the remaining three years counted from *Pramathi*, (the
3
13th of the Chacra) as zero, would give *Chitrabhanu* the 16th of the Cycle, for the name of the current year; so that by a circuitous road, that of the Cali yug to which it corresponds might be discovered, and the rest would follow.

According to the Siddhantas.

The same thing may also be said of the year of the Chacra, when referred to the mean heliocentric motion of Jupiter, which seems still more irreducible, than the Tellinga, when proposed only by its name, and number of cycles expired.

The year of Jupiter which answers to any year of the Cali yug, according to the account of the Surriah Siddhanta, may always be found, by a very simple process, the particulars of which were given in a Postscript to the third Memoir of this collection, and which for the same year 4923, will elicit *Vijaya* the 27th of the cycle.

When the Epoch is known within 60 years, and the specific name of the current Vrihaspati year is given, then the concurring year of the Cali yug may be discovered by means that were indicated in the second Appendix.

NOTE.

I have not been able to discover upon what authority Dr. Hutton places the Epoch of the Creation of the world in A. A. C. 4007, as he does in the Chronological Table which he has published in his Mathematical Dictionary, vol. I, page 434. For independently of the *Port Royal* writers, who have fixed it in A. A. C. 4004, I find the following passage in Voiron's continuation of Bailly's Astronomy.

" La Place determine deux Epoques Astronomiques tres remarquables; la premiere par la
" coincidence du grand Axe de l'orbe terrestre avec la ligne des Equinoxes; la seconde par sa
" position perpendiculaire sur cette ligne—il freit remonter la premiere a l'an 4004 avant Jesus
" Christ, *tems ou la pluspart des Chronologistes placent la Creation du monde*; la seconde a l'an
" 1250 de l'Ere Chretienne." Page 197.

Notwithstanding these testimonies, Dr. Hutton's authority is too respectable to be laid aside, without knowing upon what ground he has decided the question; and on that account I have preserved his Epoch in the Table inserted at page 302.

END OF APPENDIX III.

APPENDIX IV.

ON THE

HINDU EPHEMERIDES.

APPENDIX IV.

Giving some account of the Hindu Ephemerides and of the subsidiary articles of the Kalendars.

The Solar and Luni-solar Kalendars contain each the same articles, but differently arranged; and as the former is computed by the Solar, or *Vakiam*, process; whereas the latter follows the Sydereal rules of the Surriah Siddhanta, there is a difference in the results which may sometimes amount to six hours of time. As for the rest, the explanation of the contents of one, is perfectly sufficient for understanding those of the other.

Of the Ravi *Panchangum.*

The Solar Kalendar, independently of the months and civil days, which (like all others) it registers, gives also the time when the most remarkable phœnomena occur. The Solar Kalendar.

The word Panchangum implies five articles, which are permanently inserted in its margin; but besides these, there are several others, which, not being *Ephemeral*, appear of course only when occasion requires it.

The margin of the Solar Kalendar always opens with an accessary article, independent of its year, but intimately connected with the moral habits and superstitions of the Hindus. It registers the name of, and the time when, the Tidhi which is coupled with any Solar day in the year, terminates: It also notices in what Pacsha (the demi-lunar corresponding month) the time is running: and lastly, when a Tidhi is repeated, or expunged out of the Chandra Panchangum. Its contents.

The permanent articles, as we have stated in article 2 of the Key to the Siddhanta Chandra mana (page 73), are Five permanent articles.

1º The name of the Nacshatra in which the Moon happens to be on any particular day; with the time of her passing to the next. The Nacshatra in which the Moon happens to be.

2º The Yogù (an Astrological Element) or the space of time during which the *sum* of the Sun and Moon's motion, amounts to one Nacshatra, or 13° 20′, with the time when that Arc is completed. The Yogu.

3º The Curna (another Astrological Element) or space of time during which the Moon's motion from the Sun amounts to 6°, there being two Curnas in a Tidhi, and the Kalendar registering the time of its ending. The Curna.

4º The Thyajum or Thyagum of the Wurjum (another Astrological Element), being the unlucky The Thyajum of the Wurjum.

period of the day, the mean duration of which is about 4 guddias (1^h 36′ European time), pending which all voluntary business of importance ought to be suspended; marking the time of its *beginning*.

When the Wurjum occurs at day time, it is called *Devi*, and when at night *Ratree*.

The Isharum or Tcharum.

5º The Isharum or Tcharum; being an account of the position of the Planets, (including Rahu ☊ and Ketu ☋) on any day in the year; and the time when either of them enters any of the four quarters, or, Padahs, of a Nacshatra; marking thus the time of their position at every 3° 20′ of the Lunar Zodiac.

Rahu ☋ and Ketu ☋ considered as Planets.

N. B.—Whenever the Planets are mentioned in the following statement, it is always to be understood that the Moon's ascending and descending Nodes are considered to be of the number, according to the Hindu notions, which account for the Eclipses, in a physical sense, by supposing these to be obscure Planets.

Accidental articles.

The accidental articles are partly Astronomical, and partly Astrological, like the permanent ones; and are as follows:

Solar and Lunar Eclipses; the Sun in the Equinoxes or Solstices, and entering a new Sign.

1º The Solar and Lunar Eclipses; the time when the Sun is in the Equinoxes or the Solstices (*Mesha Ayana, Tula Ayana,* meaning the Equinoxes; *Vutra Ayana, Detchana Ayana*, the Solstices); and also the time of his entering a new Sign.

The *Crantum*.

2º The *Crantum* (an Astrological Element). I have been at some pains to understand distinctly the nature of this article, as well as that of the *Vethei*, which is connected with, and follows it; and I am not without some doubts whether after all, I have construed either accurately. What follows is therefore, the best that I could make out of the account given to me of both by my instructor.

The literal meaning of *Crantum*, is *overpowered;* and *that* of any Planet, is when it is in conjunction with, or is overpowered by, the Moon; which consequently implies, that the time of new Moon is the Sun's Crantum.

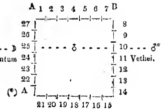
Mars, Saturn, Rahu ☊ and Ketu ☋, have a bad influence in Crantum, and mark unlucky days. The other Planets have also their Crantums, but being innoxious, they are not noticed in the Panchangum.

The *Vethei*.

3º The *Vethei* (also an Astrological Element). The literal meaning of this word is to *break*, to *cleave*, or to *corrupt*. The *Vethei* is determined by the Planet to which it refers, being in opposition to the Moon in a particular arrangement of the Lunar Zodiac; which certainly does not imply in all cases a real opposition in the Heavens; it is supposed to be the converse of the *Crantum*, and to partake of its good and bad influences and qualities.

The construction of the Crantum and Vethei explained.

The Native Astrologers use a Diagram to explain these phœnomena, of which here follows a representation.



Let the 27 regular Nacshatras, together with the Abhijit (*) or extraordinary one, be disposed in a square, each side of which contains seven Nacshatras. Let the Earth stand somewhere in the interior of this square, and conceive the Planets to revolve around it, the Moon being the nearest to the Earth. The *magical* square so constructed, is called *Servatoo Bhadra Chacra*.

Now the day on which the Sun or Planet is in a *Nacshatru* with the Moon on a line with ☽, ♁, is the *Crantum* of the Sun or Planet referred to.

But, (every thing besides remaining as before) if the same Planet, instead of being in ♂′, happens to be in ♂″ in a Nacshatra as far distant from B, as ☽ is of A, then it is in *Vethei*.

Thus if A represents the Nacshatra *Aswini* (the 1st), and the Moon be in the third before A, i. e. in *Purva Bhadrapada* (the 25th), and if the Planet *Mars* appears from the Earth in the latter Nacshatra on the same day, then it is overpowered, or in *Crantum*.

But if at the time that the *Moon* is in three Nacshatras *behind* A, *Mars* is in three Nacshatras *before* B, or which is the same thing in ten before A, (which in the present supposition will be *Magha*), then ♂″ is in *Vethei*, or corrupted.

It needs no great reflection to perceive that such a scheme belongs neither to regular Astronomy, nor Astrology; but savours more of the art of *magic* than any thing else: for even Astrology, where it is connected with Astronomy, is symmetrical; and uses regular constructions, even though its ultimate object be fantastical.

Here on the contrary, we see the extraordinary Nacshatra *Abhijit*, which contains only an Arc of 5° (3° 20′ of which it borrows from *Uttara A'shád'ha* the 21st, and 1° 40′ from *Srávana* the 22d, so as to leave the Lunar Zodiac to consist, as before of 360°) reckoned in the magical square as an *entire* and additional one of 13° 20′. And again, if the Moon happens to be at the top or bottom of the square, and a Planet be in *Vethei*, so far from the line which passes through the Moon, the Earth and the Planet, dividing the Heavens into two equal parts, (as an opposition implies) it cleaves it in two segments of 21 and 7 Nacshatras each.

In either cases of the *Crantum* or *Vethei*, Mars, Saturn, Rahu ☊ and Ketu ☋, have an evil influence: and therefore, no marriage ceremony, nor any other of rejoicings ought to be performed. But the *Srardum*, or ceremonies for deceased ancestors, or relatives, may go on as usual.

The *Latta.*

4° The *Latta* (also an Astrological Element). This word literally means *struck*, *kicked*, and like the former, has its application to the concerns of mankind.

There are two sorts of *Lattas*, viz. the Eastern and the Western ; those of the Sun, Mars and Saturn, being accounted East, and of Rahu ☊ and Ketu ☋ West.

The conception of this fanciful Element is as follows :

Manner of computing the same.

Whenever the Sun is in 12 Nacshatras (the other Planets have a different scale) counted Eastward from that in which the Moon happens to be, then it is *Latta* or struck. Mars, and Saturn's *Lattas* are also *East*, but they are struck, the former in the 9th, the latter in the 3d Nacshatra from that of which the Moon is in possession. On the contrary, Rahu ☊ and Ketu ☋ (because I suppose their motion is retrograde) are kicked in the 8th and 9th Nacshatra from the Moon, on the *West*. The other Planets not mentioned in the above list, have also their turn of chastisement, but as they bear it patiently, and do not repeat it on mankind, no notice is taken of it in the Panchangum.

When the Latta is accounted East, the Nacshatras are to be counted from the Moon, according to their order in the Lunar Zodiac ; and when West, contrary to it. Thus, for example, if we suppose the Moon in the Nacshatra *Swáti* (the 15th) and if the Sun be in *Uttara Bhadrapada* (the 26th among the regulars, but the 27th on account of the *Abhijit*), then it is Latta. But if Rahu ☊ be at the same time in Pushia (the 7th in the Zodiac, and as the Moon is supposed to be in the 15th, the 8th from the Moon), then it is also *Latta*.

The days on which the *Grantum*, *Vethei*, and *Latta* fall, when referred to the Sun, Mars, Saturn, Rahu and Ketu, are inauspicious ones.

This critical circumstance, which can only occur once in a month for each of the above mentioned Planets, imposes the same restrictions as the *Grantum* and *Vethei*.

Such are the principal Astronomical and Astrological articles of the Indian Ephemerides ; which I have endeavoured to understand, and explain, in order to shew the cause of those pretences of religious and moral inhibitions, under the screen of which the Natives of all classes postpone business, or neglect their duties, often to the great inconveniency of the public service, but more particularly of that of private individuals. (*)

Besides the articles above particularized, the Panchangum exhibits a variety of notices which refer principally to religious observances. Such are the birth days, accessions, and anniversaries of memorable events and feats of certain gods, goddesses, spirits, patriarchs and other worthies ; including the anniversaries of the beginning of the Calpa, Manwantaras, Mahayugs, and of the four lesser Yugs of the Manwantara in which we live.

Anniversaries generally observed.

The anniversaries which are more particularly specified, are those of the ten incarnations of Vishnu ; those of the *Gowries* (certain female spirits or genii on which the *Vritham* or solemn, fast is to be kept) and the accession of the patriarchs, fourteen in number ; which are supposed

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(*) There is an opinion among a certain set of Brahmins, that in those Luni-solar years where two months are repeated, and one is expunged, no religious ceremony ought to be performed during the first intercalated Lunar month of the said year. This proposition having been argued in the year 1822 (which presented a case in point) in a full Sanhedrim of Brahmins and Pundits at Madras, was condemned as *heretical* ; and the Brahmin who supported it was excommunicated.

to preside successively over the fourteen Manwantaras (308448000') which, with the *Sandhya* or twilight (1728000'), constitute the Calpa (4320000000').

It is the opinion of some divines, that the Calpa formerly consisted only of nine Manwantaras, each of which contained, as at present, 71 Mahayugs: but as it does not enter into the plan of this article to enter into the Cosmogony or Theology of the Hindus, I only mention it with a view to a few remarks on the names of the fourteen patriarchs or *Manus*, whose anniversaries are now kept, and whose names I shall give, because they are little known; stating at the same time, the Lunar months, Pacshas, and Tidhis on which they are respectively observed.

The 14 Manus.

Names and number of Manus.		Tidhis on which observed.		Lunar months.	Pacshas.
		Numeral.	Names.		
1	Swáyambhuva	12	Duadesi	Cartign	Sucha.
2	Swáróchisha	9	Navami	Aswina	Do.
3	Uttama	3	Tritia	Chaitra	Do.
4	Támasa	3	Tritia	Bhádrapada	Do.
5	Rayvata	11	Yeckadesi	Paushia	Do,
6	Icshwácu	10	Desami	A'shád'ha	Do.
7	Vaywaswata	17	Septami	Magha	Do.
8	Brahma Sávarni	15	Pavurnami	Phalguna	Do.
9	Rudra Sávarni	8	Astami	A'shád'ha	Christna.
10	Dacsha Sávarni	8	Astami	Cartiga	Do.
11	Agni Sávarni	30	Amavasya Th.	Sravana	Do.
12	Súrya Savárni	8	Astami	Bhádrapada	Do.
13	Rouchya	15	Pournami	Chaitra	Sucha.
14	Bhouchya	15	Pavurnami	Jyaishtá	Do.

Remark on their number and names.

Among the names of the patriarchs, it is remarkable that five bear the additional one of *Sávarni*; that the name of the 8th is *Brahma*, the 9th *Rudra* (the same as Siva), and that the 12th bears the name of the Sun. Whether *Dacsha* the 10th refers to *Vishnu*, and *Agni* the 11th to the Moon, I do not pretend to know; but this seems possible, from the quality, and arrangement of the five which bear the cognomen of *Sávarni*. If so, it would be a strong indication that (since three bear evidently no patriarchal names) the whole have been interpolated.

The 10 incarnations of Vishnu

Fasts of the Gowries.

The remaining anniversaries, as has already been stated, are those of the ten incarnations of Vishnu (*) and of the Gowries, on which the *Vritham* is kept; but I am not sufficiently versed in Hindu Mythology, nor have I space enough at command, to give a specific account of their nature, names, and dates of observance.

(*) There are ten names under which Vishnu appears in the Kalendar, viz. 1, Matsyadeva. 2, Coorma. 3, Varaha. 4, Narasimha. 5, Vamana. 6, Parasurama. 7, Sri-rama. 8, Bala-rama. 9, Sri-krishna. 10, Cali or Calki, according as he assumed the aspect of a Fish, a Tortoise, a Wild Hog, Lion and Man, a Dwarf, a Brahmin, a Cshetria, a Shepherd, and a Horse with a human face. Of the *Gowries*, I am told the number is considerable.

Local holy days. Feasts of the principal pagodas in the neighbourhood.

The Panchaugum also notices the local holy days, and the feasts of the most considerable pagodas, situated about 100 miles around the place for which the Kalendar is computed; besides other items of a religious, or superstitious nature (for even an idolatrous religion may know these distinctions), which will be easily understood when met with in the Kalendar, and therefore need not be enumerated.

Civil articles.

Duration of the artificial days and nights.

Prediction of abundance and scarcity.

Rural occupations.

Lastly: There will be found in the margin of the Panchangum certain articles of a civil description, such as the length of the artificial solar days, and nights, indicated at least once in the course of the month; the Sun's entrance into the different Signs of the *Tropical Zodiac*, and those predictions, of abundance *(Vridhiarga)*, middle state of prosperity *(Samarga)*, and of scarcity *(Sooniarga)*, intended to point out the proper seasons for rural occupations; just in the same manner as these contingencies were formerly announced in a *far famed* Almanac, published at Liege, under the fictitious name of *Mathieu Landsberg*, which sold for six pence throughout the Continent of Europe, and might have vied with, and perhaps excelled, the Indian Patras, in the absurdity of its articles.

NOTE.

All the articles of the Hindu Ephemerides inserted in the Patras, are given in an abridged form; and are so contracted, that what fills five pages in the translation, is contained in one of the original. In the Peninsula, the *Ravi Panchangum*, is generally published in the *Tumul* Idiom; and the Chandra Panchangum, in the Teloogoo: on which account they are known by the name of the *Tumul*, and *Teloogoo Kalendars*.

A translation of the first page of the Tamul Solar Kalendar (Ravi Panchangum) for the year of the Caliyug 4926 current, answering to A. D. 1824, computed in Solar time and with the Elements given in the Aria Siddhanta for the Latitude and Meridian of Fort St. George.

Years of the Caliyug elapsed 4925. From the birth of Salivahana 1746. Of the Æra Vicramaditya 1881. Of the Vrihaspati Chacra, Tellinga account, Tarana (the 18th). Do. Benares account, Manmat'ha (the 29th). Of the Grahaparivrithi or Cycle of 90 years, the 48th.

A. D. 1824. APRIL.

KALENDAR.

European date, April.	Theidi or Tamul date.	Feriæ.	**MONTH CHAITRAM** (Bengal Vaisácha). *Ephemerides.*
11	1	Sunday.	Triodesi (the name of the concurrent Lunar Tidhi) it's end 47^g 20^v (after apparent time of Sun rising) — ☽ in Nacshatra Purva Phalguni, passes to the next at 3^g 38^v—Yogà Vriddhi (the 11th) ends at 2^g 50^v—Do. Dhruva (12th) ends 53^g 5^v—Curna Coulava (the 3d) ends 19^g 50^v—Thyagum of Wurjum, Devi (day time) begins at 20^g 41^v—Mesha Vishuvat (indicating that certain religious ceremonies which depend on the recurrence of the Vernal Equinox are to be performed.—Samarga (mean state of agricultural prosperity—time proper for sowing the fields)—Ahus (or Dinarda duration of the artificial day) 30^g 40^v—Mercury enters the second Padah (quarter) of Nacshatra Aswini at 54^g—Jupiter enters the third Padah of Nacshatra A'rdrà 16^g—Mars' Crantum in Nacshatra Purva Phalguni (no marriage ceremonies on account of the Crantum)—The Sun and Rahu (☽'s ☊) are Latta—[illegible]na (state of unfavourable prospects) no Srardum (ceremonies for deceased ancestors)—Madana Triodesi (the last day of a festival begun before).
12	2	Monday.	Chaturdasi, ends at 42^g 53^v—☽ in Nacshatra Uttara Phalguni, ends at 0^g 23^v—passes on the same Tidhi into Nacshatra Hasta, ends 57^g 33^v—Yogù Vyagatha (13th) ends 49^g 43^v—Curna Garujah or Yurka (5th) ends 15^g 6^v—Thyagum of Wurjum, begins 21^g 34^v—Venus enters 1st Padah (quarter) of Nacshatra Uttara Bhadrapada 15^g—No ceremonies allowed on this day.
13	3	Tuesday.	Purnima Tidhi (day of full Moon), ending at time of apparent opposition, which occurs at 39^g 16^v—☾ in Nacshatra Chitra, end 56^g 26^v—Yogù Hershana (14th) ends 44^g 5^v—Curna Bhadra (7th) ends 11^g 5^v—Thyagum of Wurjum, Devi (day time) begins 17^g 30^v—Mercury enters 3d Padah of Nacshatra Aswini at 44^g—Mars is Latta—Accession of Rouchya Mann (one of the fourteen presiding spirits of the

APRIL.

KALENDAR.			
European date, April.	Thidi or Tamil date.	Feriæ.	*Vaisácha*, or *Chaitram*, continued. *Ephemerides.*
			Calpa divided into 14 Manwantaras)—Chaitra Purnima (day of full Moon in Chaitram) a Tidhi of general observances and ceremonies.
14	4	Wednesd.	Chistna Pacsha (the dark half of the month) Padyami (1st Tidhi of the said Pacsha) ends 36g 41v—☽ in Nacshatra Swati, ends 55g 50v—Yogù Vajra (15th) ends 39g 13v—Curna Bhalava (2d) ends 7g 58v—Thyagum of Wurjum, Devi (d. t.) begins 10g 18v—Sun enters 2d Padah of Nacshatra Aswini 16g 21v—Venus enters 2d Padah of Nacshatra Uttara Bhadrapada, 58g—Saturn enters 3d Padah of Nacshatra Criticá 34g.
15	5	Thursday	Duitia T. ends 35g 0v—☽ in Nacshatra Visac'ha, ends 56g 21v—Yogù Siddhi or Asrij (16th) ends 35g 20v. Curna Dhitala (4th) ends 5g 51v—Thyagum of Wurjum, Devi (d. t.) begins 9g 58v—Mercury enters 4th Padah of Aswini 31g.
16	6	Friday.	Tadya T. ends 34g 41v—☽ in Nacshatra Anurádhà, ends 58g 13v—Yogù Vyatipáta (17th) ends 32g 24v—Curna Waronji (6th) ends 4g 51v—Thyagum of Wurjum, Devi (d. t.) begins 6g 42v—Garoodavahana, Triplicane feast.
17	7	Saturday.	Chouti T. 35g 42v—☽ in Nacshatra Jyést'ha, ends 60g—Yogù Vari'yas (18th) ends 30g 27v—Curna Bháva (1st) 5g 11v—Thyagum of Wurjum, Devi (d. t.) begins 12g 56v—Sun enters 3d Padah of Nacshatra Aswini 39g 52v—Mercury enters 1st Padah of Bharani 26g—Venus enters 3d Padah of Nacshatra Uttara Bhadra 41g.
18	8	Sunday.	Panchami T. ends 37g 50v—☽ in Nacshatra Jyést'ha ends 1g 17v—Yogù Parigha (19th) 29g 18v—Curna Coulava (3d) ends 6g 40v—Thyagum of Wurjum, Devi (d. t.) begins 22g 13v—Matsya deva (anniversary of Vishnu's incarnation as a *Fish*).
19	9	Monday.	Shusti T. ends 41g 10v—☽ in Nacshatra Mula, ends 5g 36v—Yogù Siva (20th) 29g 35v—Curna Garujah (5th) ends 9g 30v—Thyagum of Wurjum, Devi (d. t.) begins 1g 20v—a 2d Thyagum, Ratri (night time) begins 0g 47v—Mercury enters 2d Padah of Bharani 19g.
20	10	Tuesday.	Septami ends 45g 30v—☽ in Purva A'shád'ha, ends 10g 53v—Yogú Siddha (21st) ends 30g 22v—Curna Bhadra (7th) ends 13g 20v—Thyagum of Wurjum, Ratri (n. t.) begins 1g 55v—Mercury visible, West 26g—Venus enters 4th Padah of Nacshatra Uttara Bhadrapada 24g—Rahu (☽'s ☊) Crantum in Nacshatra Purva A'shád'ha.—*Rahtot Savam*, feast of the great chariot in Triplicane.
21	11	Wednesd.	Astami T. ends 50g 16v—☽ in Nacshatra Uttara A'shád'ha, ends 16g 55v—Yogù Sadhya (22d) ends 31g 32v—Curna Bhalava (2d) ends 17g 58v—Thyagum of Wurjum, Devi (d. t.) begins 27g 58v—Sun enters 4th Padah of Nacshatra Aswini; 6g 10v—Sun also enters the *Tropical* Zodiacal Sign Vrisha ♉ at 14g 35v—Mercury enters 3d Padah of Nacshatra Bharani at 12g—Ahus (duration of artificial day) 31g.

APRIL.

KALENDAR.			
European date, April.	Theidi or Tamul date.	Feriæ.	*Vaisácha, or Chaitram,* continued. *Ephemerides.*
22	12	Thursday	Navami T. 55g 17v—☽ in Nacshatra Srávana 23g 16v—Yogù Subha (23d) 33g 0v—Curna Dhitala (4th) 22g 43v—Thyagum of Wurjum, Ratri (night time) 3g 20v—Satrica Vethei (no marriage ceremonies).
23	13	Friday	Desami T. 60g—☽ in Nacshatra Dhanish'tà 29g 43v—Yogù Subra (24th) 34g 20v—Curna Warnajee (6th) 27g 47v—Thyagum of Wurjum, Ratri (night time) 18g 27v—Mercury enters 4th Padah of Nacshatra Bharani 4g—Venus enters 1st Padah of Revati 7g—This Tidhi (Desami) is Adigah, being repeated and called Tridina Sprohuo.
24	14	Saturday	Desami T. 0g 16v—☽ in Nacshatra Satabhisha 35g 12v—Yogù Brahman (25th) 35g 27v—Curna Bhuddrava (7th, only *one* in advance from the last instead of two, on account of the day being repeated) 0g 16v—Thyagum of Wurjum, Ratri (night time) 22g 2v—Sun enters 1st Padah of Nacshatra Bharani 32g 42v—Mercury enters 1st Padah of Nacshatra Critica 57g.
25	15	Sunday	Yecadesi T. 4g 35v—☽ in Nacshatra Parva Bhadrapada 41g 3v—Yogù Maha Indra (26th) 36g—Curna Bhalava (2d) 4g 35v—No Thyagum of Wurjum—Venus enters second Padah of Nacshatra Revati 50g—Ketu (☽'s ☋) is Latta. A general fast, the men's foreheads to be painted according to castes.
26	16	Monday	Duodesi T. 8g 0v—☽ in Nacshatra Uttara Bhadrapada 45g 25v—Yogù Vaidrithi (27th) 35g 50v—Curna Dhitala (4th) 8g 0v—Thyagum of Wurjum, Devi (day time) 6g 48v—Mars ceases to be retrograde and begins to proceed direct 42g—Mercury enters 2d Padah of Nacshatra Critica in Vrisha ♉ 56g—Varaha Jyanti's birth day.
27	17	Tuesday	Triodesi T. 10g 18v—☽ in Nacshatra Revati 48g 36v—Yogù Vishcambba (1st) 34g 43v—Curna Warnajee (6th) 10g 18v—Thyagum of Wurjum, Devi (day time) 17g 1v—Sun enters 2d Padah of Nacshatra Bharani 59g 2v—Mars is Vethei (no marriage ceremonies; the Srardum or observance for the dead as usual).
28	18	Wednesd	Chaturdasi T. 11g 20v—☽ in Nacshatra Aswini 50g 32v—Yogù Príti (2d) 32g 35v—Curna Soyami or Shakoni (8th) extraordinary 11g 20v—Thyagum of Wurjum, Ratri (night time) 9g 8v—Venus enters 3d Padah of Nacshatra Revati 33g.
29	19	Thursday	Amavasaya or conjunction day (being the 30th Tidhi of the Lunar month and the last or 15th of the Christna Pacsha) 11g 10v—☽ in Nacshatra Bharani 51g 18v Yogù Ayushmat (3d) 29g 28v—Curna Nayava (10th extraordinary) 11g 10v—Thyngum of Wurjum, Devi (day time) 14g 50v—Mercury enters 3d Padah of Nacshatra Critica 3g—Sun's Crantum in Nacshatra Bharani. On Amavasaya or conjunction, a general observance of principal rites.
30	20	Friday	Padyami or Prathama Tidhi (1st of the Sucha Pacsha or enlightened half of the Lunar month) 9g 46v—☽ in Nacshatra Critica 50g 53v—Yogù Saubhágya (4th)

MAY.

KALENDAR.			
European date, May.	Theidi or Tamul date.	Feriæ.	*Vaisâcha*, or *Chaitram*, continued. Ephemerides.
			25g 30v—Curna Bhava (1st) 9g 46v—Thyagum of Wurjam, Devi (day time) 21g 8v—Saturn sets West 37g, his Crantum (no marriage ceremony) This day is the 1st of the Luni-solar month of the Tellingas The Moon's crescent begins to appear this evening at Sun set, and the Muhommedan Civil month Ramzan commences.
May 1	21	Saturday	Duitya or Vidya 7g 13v—☽ in Nacshatra Rohini 40g 42v—Yogù Sóbhana (5th) 20g 32v—Curna Coulava (3d) 7g 13v—Thyagum of Wurjum, Devi (day time) 30g 6v—Sun enters 3d Padah of Nacshatra Bharani 25g 45v—Mercury enters 4th Padah of Nacshatra Critica 21g—Venus enters 4th Padah of Nacshatra Revati 16g—Trita yuga dina, or anniversary of the day on which the Trita yug began—Birth day of Balaram Deo.—*Acshaya* Tritya (the current Tidhi), a lucky day.
2	22	Sunday	Tritya T. 8g 41v—The next Lunar Tidhi, called Chouti, is a Cshaya or expunged one (and therefore intervening between Tritya and Punchami) ends at 55g 32v—☽ in Nacshatra Mrigasiras 47g—Yogù Atiganda (6th) 14g 51v—Curna Yurka (5th) the same as Garujee 8g 41v—Second Curna (on account of expunged Tidhi) Vurnaja (6th) 27g 46v—Thyagum of Wurjum, Devi (day time) 3g 5v—Abus (duration of artificial day) 31g 15v—This is marked Avamaha on account of the expunged Tidhi.
3	23	Monday ●	Punchami T. 54g—☽ in Nacshatra A'rdrà 43g 51v—Yogù Sucarma (7th) 8g 25v—Curna Bhava (1st) 26g 37v—Thyagum of Wurjum, Devi (d. t.) 6g 52v—Mercury enters 1st Padah of Nacshatra Rohini 42g—Jupiter enters 4th Padah of Nacshatra A'rdrà 52g—Venus enters 1st Padah of Aswini in Mesha ♈ 59g—Ketu's (☽'s ☋) Crantum (no marriage ceremonies)—Sun's Vethei—Streepermadoro feast—Yembramanu's birth day.
4	24	Tuesday	Shasti T. 48g 23v—☽ in Nacshatra Punarvasu 40g 14v—Yogù Dhriti (8th) 1g 31v—the next Yogù Sûla (9th) 52g 42v—Curna Coulava (3d) 31g 12v—Thyagum of Wurjum, Devi (day time) 12g 4v—2d do. Ratri (night time) 27g 38v—Sun enters 4th Padah of Nacshatra Bharani 52g 14v.
5	25	Wednesd.	Septami T. 42g 32v—☽ in Nacshatra Pushia 36g 18v—Yogù Ganda (10th) 46g 38v—Curna Garujee (5th) 15g 28v—Shesha (complement of) Thyagum 2g 54v—favourable day for marrying.
6	26	Thursday	Astami T. 36g 28v—☽ in Nacshatra Asleshà 32g 16v—Yogù Vriddhi (11th) 39g 0v—Curna Bhuddra (7th) 9g 30v—Thyagum of Wurjum, Devi (day time) 6g 10v—Mercury enters 2d Padah of Nacshatra Rohini 11g—Venus enters 2d Padah of Nacs. Aswini 42g.
7	27	Friday.	Navami T. 30g 30v—☽ in Nacshatra Maghà 28g 14v—Yogù Dhruva (12th) 31g 25v—Curna Bhalava (2d) 3g 29v—Thyagum of Wurjum, Devi (day time) 0g 15v—2d Do. Ratri (night time) 15g 36v—Saturn's Latta.

	Kalendar.			
	European date, May.	Theidi or Tamul date.	Feriæ.	*Vaisácha*, or *Chaitram*, continued. *Ephemerides.*
MAY.	8	28	Saturday.	Desami T. 24g 46v—☽ in Nacshatra Purva Phalguni 21g 25v—Yogù Vyághâta 24g 7v—Curna Garujee (5th) 24g 46v—Thyagum of Wurjum, Ratri (night time) 10g 1v—Sun enters 1st Padah of Nacshatra Criticà 18g 56v—Mercury enters 3d Padah of Nacshatra Rohini 45g.—N. B. On Desami Tidhi the Srardum (ceremony for deceased ancestors) to be observed.
	9	29	Sunday.	Yacadesi T. 19g 34v—☽ in Nacshatra Phalguni 21g 8v—Yogù Hershana (14th) 17g 10v—Curna Budhrava (7th) 19g 34v—Thyagum of Wurjum, Ratri (night time) 10g 35v—Venus enters 3d Padah of Nacshatra Aswini 25g—Saturn enters 4th Padah of Nacshatra Criticà 59g—Mercury's Crantum—Rahu's (☽'s ☊) Latta.
	10	30	Monday.	Duadesi T. 15g 6v—☽ in Nacshatra Husta 18g 34v—Yogù Vajra (15th) 10g 45v—Curna Bhalava (2d) 15g 6v—Thyagum of Wurjum, Ratri (night time) 6g 30v—N. B. The ceremonies suspended on Tryadesi, the 1st day of this Solar month, (Mesha masa or month of Aries) to be performed on this day.
	11	31	Tuesday.	Tryadesi T. 11g 20v—☽ in Nacshatra Chitra 16g 46v—Yogù Asrij or Siddhi (16th) 5g 0v—next Yogù Vyatipáta (17th) 54g 55v—Curna Dhitala (4th) 11g 20v—Thyagum of Wurjum, Devi (day time) 30g 34v—Sun enters 2d Padah of Nacshatra Criticà, in the Solar Sign Vrisha ♉ 46g 47v—Mercury enters 4th Padah of Nacshatra Rohini 27g—Sun and Mars' Latta.——N. B. The ceremonies suspended on Chaturdesi to be performed on this day.

End of the Solar month Chaitram, or Vaisácha.

A translation of the first page of the Tellinga Kalendar (Siddhanta Chandra mana) for the Luni-solar year 4926 *commencing, answering to the* 1747*th of the Æra of Salivahana ; the expired years of the former being the* 4925*th, and of the latter the* 1746*th ; and of the Æra Vicramaditya the* 1881*st, all corresponding to the year of Christ* 1824*. The name of the current year of the Cycle of* 60 *(Vrihaspati) being* Tarana, *according to Tellinga account ; and* Manmat'ha, *Benares reckoning. Computed with the Elements of the Surriah Siddhanta for the Meridian and Latitude of Fort St. George.*

KALENDAR.

European date, March.	Solar date, Tamul Poongoni or Chaitram.	Chaitra, Luni-solar date.	Feriæ.	Lunar Month *Chaitra*, the first of the Luni-solar year. *Ephemerides.* Sucha Pacsha, or enlightened half of the month.
31	20 Tropical Zodiacal Sign Mesha ♈	1	Wednes.	End of Tidhi $36^g\ 3^v$—Moon in Nacshatra *Revati*, passes to the next at $27^g\ 31^v$—Yogù *Maha Indra* (26th) ends $14^g\ 18^v$—Curna *Khimostogana* (11th) ends at $5^g\ 43^v$—No Thyajum of Wurjum—Sun enters 2d Padah (quarter) of Nacshatra Revati, at $46^g\ 34^v$—Sun's *Crantum*—Mars' *Vethci*—Annual fast of Samvatsara Gowry *Vritham* (bathing and other rites).
April 1	21	2	Thursday	End of Tidhi $36^g\ 18^v$—Moon in Nacshatra Aswini, passes to the next at $29^g\ 30^v$—Yogù *Vaidhriti* (27th) ends $12^g\ 13^v$—Curna Bhalava (2d) ends $6^g\ 11^v$—Thyajum of Wurjum, 1. Devi (day time) begins $19^g\ 11^v$. 2. Ratri (night time) $23^g\ 2^v$—*Mercury* enters 4th Padah of Nacshatra *Uttara Bhadrapada*, at 15^g—*Venus* enters 1st Padah of Nacshatra *Purva Bhadrapada* at 22^g—Duration of the artificial day, (*Din Arda*, Sungscrete; *Ahus*, Tellinga) $30^g\ 20^v$.
2	22	3	Friday	End of Tidhi $35^g\ 17^v$—☽ in Nacshatra Bharani, passes to the next at $30^g\ 15^v$—Yogù *Vishcambha* (1st) ends at $9^g\ 7^v$—Curna *Dhitala* (4th) ends $5^g\ 48^v$—Thyajum of Wurjum, none—Accession of *Uttama Manu* (Patriarch)—Vritham or fast of Gowri *Sow baghia*.
3	23	4	Saturday	End of T. $33^g\ 6^v$—☽ in Nacshatra *Critica* $29^g\ 50^v$.—1. Yogù *Priti* (2d) $48^g\ 52^v$. 2. Yogù *Ayushmat* (3d) $55^g\ 7^v$—Curna Warnajee (6th) $4^g\ 11^v$—Thyajum of Wurjum, *Devi* begins $0^g\ 3^v$—Mercury enters 1st Padah of Nacshatra *Revati* 2^g—Saturn's *Crantum*.
4	24	5	Sunday	End of T. $29^g\ 50^v$—☽ in Nacs. *Rohini*, passes $28^g\ 25^v$—Yogù *Saubhágya* (4th) ends $54^g\ 10^v$—Curna *Bhava* (1st) ends $1^g\ 27^v$—Thyajum of Wurjum, *Devi* begins $8^g\ 54^v$—Do. *Ratri* $18^g\ 25^v$—Sun enters 3d Padah of Nacshatra Revati $9^g\ 57^v$—Mercury enters 2d Padah of Revati $0^g\ 0^v$—

KALENDAR.				*Chaitra*, continued. *Ephemerides.*
April.	Poongoni or Chaitram.	Chaitra.	Feriæ.	Sucha Pacsha.
				Venus enters 2d Padah of Purva Bhadra 5g—*Calpa dia*, anniversary of the beginning of *Calpa*.
5	25	6	Monday	End of T. 25g 46v—☽ in Nacshatra Mrigasiras (5th) issues at 26g 7v—Yogù Sóbhana (5th) ends 47g 42v—Curna *Dhitala* (4th) ends 25g 46v—Thyajum of Wurjum, *Ratri* begins 15g 32v—Tidhi Shusti, on which there is *Srardum*, or ceremonies for the dead.
6	26	7	Tuesday	End of Tidhi 20g 51v—☽ in Nacshatra A'rdrà (6th) issues 23g 1v—Yogù Atiganda (6th) ends 40g 43v—Curna Warnajee (6th) ends 20g 51v—Thyajum of Wurjum, *Ratri* begins 20g 43v—Mercury enters 3d Padah of Nacshatra Revati 34g—Venus enters 3d Padah of Nacs. Purva Bhadrapada at 38g—Ketu's (☽'s ☋) *Crantum*—Sun's *Vethei*—Tidhi *Duitia*—Santara Septami; ceremonies for the dead, (meaning that the ceremonies which ought to have been performed on the 2d Tidhi are postponed until this day.)
7	27	8	Wednesd	End of Tidhi 15g 27v—☽ in Nacshatra Punarvasu (7th) issues 19g 25v—Yogù *Sucarman* (7th) ends 32g 21v—Curna *Bhava* (1st) ends 15g 27v—Thyajum of Wurjum, Ratri begins 7g 35v—Sun enters 4th Padah of Nacshatra Revati at 33g 38v—Navami Tidhi—*Srardum* ceremonies for the dead—Sri Ram's birth day.
8	28	9	Thursday	End of Tidhi 9g 33v—☽ in Nacshatra Pushia 15g 27v—Yogù Dhriti (8th) 25g 40v—Curna Coulava (3d) 9g 33v—Thyajum of Wurjum, Ratri (night time) begins 14g 42v—Mercury enters 4th Padah of Nacshatra Revati 20g.
9	29	10 Cshaya.	Friday	End of Tidhi 8g 29v—Oppadi (expunged) Tidhi, ends 54g 0v, its name Yacadesi—☽ in Nacshatra Asleshà 11g 18v—Yogù Súla (9th) 18g 1v—Curna Garujah (5th) 3g 29v—2d Curna (of the expunged day) Warnajee (6th) 27g 0v—Thyajum of Wurjum, Ratri (night time) 8g 31v—Mars *retrograde*, enters 2d Padah of Nacshatra Phalguni 8g—Venus enters 4th Padah of Nacs. Purva Bhadrapada in the Solar Sign Min ♓ 31g—On account of the Oppadi, or Avamaba Tidhi Yacadesi, the distinguishing marks of castes to be generally painted on the forehead.
10	30	12	Saturday	End of Tidhi 51g 50v—☽ in Nacshatra Maghà 7g 10v—Yogù Ganda (10th) 10g 25v—Curna Bhava (1st) 24g 40v—Thyajum of Wurjum, Devi (day time) 25g 24v—Sun enters 1st Padah of Nacshatra Aswini and the Sign of the fixed Zodiac Mesha at 57g 43v—Mercury enters 1st Padah of Nacshatra Aswini in the Sign Mesha at 6g—Saturn's Latta—This Tidhi Yacadesi, a fast for the followers of Vishnu.

KALENDAR.

April.	Chaitram or Vaisácha.	Chaitra.	Feriæ.	*Chaitra*, continued. *Ephemerides.*
				Sucha Pacsha ends. Christna Pacsha (or dark half of the month) begins,
11	1	13	Sunday	End of Tidhi 46g 24v—☽ in Nacshatra Porva Phalguni ends 3g 18v—Do. in Uttara Phalguni ends 56g 41v—Yogù Vriddhi (11th) ends 2g 57v—Do. Dhruva (12th) ends 53g 0v—Curna Coulava (3d) ends 19g 5v—Thyajum of Wurjum, Devi (day time) begins 20g 19v.—Mercury enters 2d Pada of Nacshatra Aswini 51g—Jupiter enters 3d Padah of Nacs. A'rdrà 16g—Mars' Crantum—Sun and Rahu's (☽'s ☊) Crantum (no marriage ceremony)—Vishuvat Panincala (certain ceremonies recurring about the Equinoxes to be performed)—Samargu (middle state of agricultural prosperity) time for sowing the fields.
12	2	14	Monday	End of Tidhi 41g 43v—☽ in Nacshatra Hasta ends 57g 22v—Yogù Vyághátu (13th) 49g 25v—Curna Garojee (5th) ends 14g 5v—Thyajum of Wurjum, Devi (day time) begins 21g 2v—Venus enters 1st Padah of Nacshatra Uttara Bhadrapada 15g.
13	3	15	Tuesday	End of Tidhi 37g 32v—☽ in Nacshatra Chitra ends 55g 16v—Yogù Hershana (14th) ends 43g 27v—Curna Bhadra (7th) ends 9g 30v—Thyajum of Wurjum, Devi (day time) begins 16g 31v—Mercury enters 3d Padah of Nacs. Aswini 44g—Mars' Latta—Accession of Rouchya Manu (the 13th of the 14 Rulers of the Calpa)—Chitra Purnima Tidhi, (the Lunar day of opposition or full Moon) general observances.
	Christna Pacsha.			
14	4	1	Wednesd.	End of Tidhi 34g 23v—☽ in Nacshatra Swáti, ends 54g 10v—Yogù Vajra (15th) ends 38g 21v—Curna Bhalava (2d) ends 5g 55v—Thyajum of Wurjum, Devi (day time) begins 8g 58v—Sun enters 2d Padah of Nacshatra Aswini 21g 51v—Venus enters 2d Padah of Uttara Bhadrapada 58g—Saturn enters 2d Padah of Nacshatra Criticà 34g—Beginning of the Triplicane feast. The Christna Pacsha (obscure half of the month) begins.
15	5	2	Thursday	End of Tidhi 32g 25v—☽ in Nacshatra Visac'ha, ends 51g 34v—Yogù Siddhi (16th) ends 34g 10v—Curna Dhitala (4th) ends 3g 24v—Thyajum of Wurjum, Devi (day time) begins 8g 23v—Mercury enters 4th Padah of Nacshatra Aswini 34g.
16	6	3	Friday	End of Tidhi 32g 44v—☽ in Nacshatra Anurádhà, ends 56g 0v—Yogù Vyatipáta (17th) ends 30g 56v—Curna Warnajee (6th) ends 2g 5v—Thyajum of Wurjum, Devi (day time) begins 4g 48v—Triplicane feast continues—Procession of Gurulatsavam.
17	7	4	Saturday	End of Tidhi 32g 15v—☽ in Nacshatra Jyést'ha ends 58g 42v—Yogù Vari'yas (18th) ends 28g 39v—Curna Bhava (1st) ends 2g 0v—Thyajum

KALENDAR.				*Chaitra*, continued. *Ephemerides.*
April.	Chaitram or Vaisácha.	Chaitra.	Feriæ.	Christna Pacsha.
				of Wurjum, Devi (day time) 10g 38v—Sun enters 3d Padah of Nacshatra Aswini 46g 22v—Mercury enters 1st Padah of Nacshatra Bharani 26g—Venus enters 3d Padah of Nacshatra Uttara Bhadrapada 41g.
18	8	5	Sunday	End of Tidhi 34g 10v—☽ in Nacshatra Mula ends 60g—Yogù Parigha (19th) ends 27g 30v—Curna Coulava (3d) 3g 12v—Thyajum of Wurjum, Devi (day time) begins 20g 0v—2d Thyajum, Ratri (night time) begins 27g 30v—Matsya deva's day, (anniversary of Vishnu's incarnation as a *Fish*).
19	9	6	Monday	End of Tidhi 37g 9v—☽ in Nacshatra Mula ends 2g 36v—Yogù Siva (20th) ends 27g 11v—Curna Garujee (5th) 5g 40v—Complement of Thyajum (the Moon having left the Nacshatra Mula on the preceding day at 60 guddias complete) called Shesha, Devi (day time) 2g 21v—2d Thyajum, Devi (day time) begins at 28g 35v—Mercury enters 2d Padah of Nacshatra Bharani 19g.
20.	10	7	Tuesday.	End of Tidhi 41g 5v—☽ in Purva A'shád'hà, issues at 7g 38v—Yogù *Siddha* (21st) ends 27g 42v—Curna Bhudra (7th) begins 9g 7v—Thyajum of Wurjum, *Devi* 29g 28v—Mercury visible in the West at 26g—Venus enters 4th Padah of Uttara Bhadrapada at 24g—Rahu's (☽'s ☊) *Crantum* in Purva A'shád'hà—Ketu's *Vethei*—Rahtot Savam (feast of the great chariot) in Triplicane.
21.	11 Tropical Zodiacal Sign Vrisha ♉	8	Wednesd.	End of Tidhi 45g 46v—☽ in Nacshatra Uttara A'shád'hà, issues 13g 21v—Yogù *Sádhya* (22d) ends at 28g 47v—Curna Bbalava (2d) ends 13g 26v—Thyajum of Wurjum, *Devi* begins 24g 25v—Sun enters 4th Padah of Nacshatra Aswini at 12g 40v—Sun enters the *Tropical Zodiacal Sign Vrisha* ♉ at 21g 25v—Mercury enters 3d Padah of Nacshatra Bharani at 12g—*Ahus* (Dinarda, or duration of artificial day) 31g 0v.
22	12	9	Thursday	Tidhi ends at 50g 55v—☽ in Nacshatra Sravana, issues 19g 44v—Yogù *Subha* (23d) ends 30g 12v—Curna Dhitala (4th) 18g 20v—Thyajum of Wurjum, Ratri begins 30g 50v—Saturn's Vethei.
23	13	10	Friday.	Tidhi ends 55g 57v—☽ in Nacshatra Dhanish'tà, issues 26g 18v—Yogù *Subra* (24th) ends 31g 48v—Curna Warnajee (6th) ends at 22g 26v—Thyajum of Wurjum, begins 15g 10v—Mercury enters 4th Padah of Nacshatra Bharani at 4g—Venus enters 1st Padah of Nacshatra Revati at 7g.
24	14	11	Saturday.	Tidhi ends at 60g—☽ in Nacshatra Satabhisha issues 32g 33v—Yogù

KALENDAR.				*Chaitra*, continued. *Ephemerides.*
April.	Chaitram or Vaisàcha.	Chaitra	Feriæ.	Christna Pacsha.
		Adigah Tidhi.		Bruhman (25th) ends at 33g 7^{v}—Curna Bhava (1st) ends 28g 15^{v}—Thyajum of Wurjum, Ratri begins at 18g 57^{v}—Sun enters 1st Padah of Nacshatra Bharani, at 39g 22^{v}—Mercury enters 1st Padah of Nacshatra Criticà at 57g—*Tridina Sproohoo* (the meaning of which is that the Lunar Tidhi Chaturdasi is repeated.)
25	15	11	Sunday.	Tidhi ends at 0g 34^{v}—☽ in Nacshatra Purva Bhadrapàda, issues at 38g 3^{v}—Yogù Maha Indra, ends at 33g 48^{v}—Curna Bhalava (2d) ends 0g 34^{v}—Thyajum of Wurjum, *none*—Venus enters 2d Padah of Nacs. Revati at 50g—Ketu's (☽'s ☋) *Latta*—a general fast—the men's foreheads to be painted according to their castes.
26	16	12	Monday.	Tidhi ends at 4g 16^{v}—☽ in Nacshatra Uttara Bhadrapada, issues at 42g 43^{v}—Yogù Vaidhriti (27th) ends at 33g 51^{v}—Curna Dhitala (4th) ends at 4g 16^{v}—Thyajum of Wurjum, Devi begins at 3g 55^{v}—Mars commences to be retrograde at 42g—Mercury enters 2d Padah of Nacshatra Criticà (in the Solar Sign Vrisha ♉) at 56g—Varaha Jyanti's birth day, (a celebrated Astronomer).
27	17	13	Tuesday.	End of Tidhi 7g 5^{v}—☽ in Nacshatra Revati issues 46g 14^{v}—Yogù Vishcambha (1st) ends 32g 56^{v}—Curna Warnajee (6th) ends 7g 5^{v}—Thyajum of Wurjum, Devi begins 11g 29^{v}—Mars' Vethei.
28	18	14	Wednesd.	End of Tidhi 8g 32^{v}—☽ in Nacshatra Aswini, issues at 48g 36^{v}—Yogù Prìti (2d) ends at 31g 12^{v}—Curna Soyami, or Shakoni (8th extraordinary) ends at 8g 32^{v}—Thyajum of Wurjum, Ratri begins at 7g 4^{v}—Sun enters 2d Padah of Nacshatra Bharani at 6g 0^{v}—Venus enters 3d Padah of Nacshatra Revati at 33g.
29	19	Amavisya 30	Thursday	Amavasya, or conjunction, occurs at 8g 47^{v}—☽ in Nacshatra Bharani issues at 49g 41^{v}—Yogù Ayushmat (3d) ends at 28g 27^{v}—Curna Nagava (10th extraordinary) ends at 8g 47^{v}—Thyajum of Wurjum, Devi begins at 13g 2^{v}—Mercury enters 3d Padah of Nacshatra Criticà at 3g—Sun's *Crantum*.

End of the Lunar month Chaitra.

END OF APPENDIX IV.

FRAGMENTS.

FRAGMENT I.

On the Formulæ of the Hindus for calculating the Eclipses, the Tables of Sines and divers other Astronomical Problems. Extracted from the French Ephemerides (Connoissance des Tems) for the year 1808, *and ascribed to Mr. Delambre.* (Page 447.)

These Formulæ will be found in the second volume of the Asiatic Researches. Altho' they may have been long since known in Europe, nevertheless as the original Memoirs first printed in Calcutta, and subsequently reprinted in London, are rather scarce, we deem it expedient to announce them to our readers, who, for the most part have never heard of their existence.

Ducham, Bailly, and Le Gentil, have published that the Indians have, for calculating the Eclipses, certain methods which they follow without understanding them.

The author of the Memoir referred to, Mr. Davis, combats victoriously that assertion, by giving in the minutest details, the computation of the Lunar Eclipse of the month of November 1789, which he worked by the Indian Formulæ; his demonstrations and illustrations being grounded on the precepts of the Surriah Siddhanta.

The space which I have at command is too confined to enter into particulars; I shall therefore only state, that I have revised all these calculations with attention, and with the exception of a few points of the Indian doctrines, and of certain suppositions, the proofs of which are not very evident, one may aver that all the rest possesses all the perspicuity which the subject matter requires.

I cannot however, abstain from offering a few words on the Indian Table of Sines, and on the two methods according to which these are calculated; for since the publication of the Memoirs, I have noticed in a note inserted at the foot of the Table, that I had not sufficiently appreciated the merits of the Indian method, because I have been led into a mistake by a constant number which seems to me not to have been exhibited in the Memoir with sufficient clearness.

In the Table under consideration the Sines are expressed in minutes; it proceeds 3°$\frac{3}{4}$ to 3°$\frac{3}{4}$ degrees, supposing the Radius to contain 3438′; or rather 3437′,75.—On the same line with the Right Sines, the Table gives the Versed Sines.

If the process prescribed by the Indian author be examined carefully, one perceives easily that his method consists merely in calculating in the first instance a first difference which at the same time is the first Sine of the Table. After which, in order to obtain the second Sine, he calculates the second difference, which he subtracts from the first difference. This process gives the first difference between the first and second Sine; and consequently *the second Sine*; after which he calculates another second difference to deduce therefrom a new first difference and a new Sine, and so forth to the end of the Table.

That process is precisely that which I indicated in the preface to the Decimal Tables of Borda, without knowing that this method, which seemed unknown even to the moderns, had been so long practised in India.

My Formulæ is $\Delta^{(2)} \text{Sin } A = - 4 \text{ Sin}^2 \tfrac{1}{2} \Delta A \text{ Sin } A = - \text{Chord}^2 \Delta A \text{ Sin } A$. See Decimal Table, page 48.

Δ being the difference, A the Arc.

ΔA, being a constant quantity in the Table of Sines, it follows that in order to have the second difference of any Sine whatever, that Sine must be multiplied by a constant number. Now ΔA in the Indian Table is 3° 45′, therefore $4 \text{ Sin}^2 \tfrac{1}{2} \Delta A = 4 \text{ Sin}^2 . 1° 52' 30'' = 0{,}0012821 = \frac{1}{233{,}533}$, from which it results that the constant factor for finding the second difference is $\frac{1}{233{,}533}$, that is to say, that the last Sine found must be divided by $\frac{1}{233{,}533}$. But according to the Memoir under consideration, that constant divisor, is $\frac{1}{225}$, which leads me to suspect that some typographical error has occurred, the more so that the numbers of the Indian author do not agree well with that divisor of 225, whereas with mine $\frac{1}{233{,}5}$, and following besides literally the precept, I find (with the exception of a few fractions) the same quantities; as may be seen in the following Table.

°	′	Indian Sines.	Sines by the French Divisor.	1st Differences.	2d Differences.
0	0	000	000,00		
3	45	225	224,85	224,85	
7	30	449	448,75	223,89	0,96
11	15	671	670,71	221,97	1,92
15	0	890	889,81	219,10	2,87
18	45	1105	1105,10	215,29	3,81
22	30	1315*	1315,56	210,56	4,73
26	15	1520*	1520,59	204,93	5,63
30	0	1719	1719,01	198,42	6,51
33	45	1910	1910,07	191,06	7,36
37	30	2093	2092,95	182,88	8,18
41	15	2267	2266,85	178,92	8,96
45	0	2431	2431,08	164,21	9,71
48	45	2585	2584,88	153,80	10,41
52	30	2728	2727,61	142,73	11,07
56	15	2859	2858,66	131,05	11,68
60	0	2978*	2977,47	118,81	12,24
63	45	3084	3083,55	106,06	12,75
67	30	3177*	3176,30	92,86	13,20
71	15	3256	3255,54	79,25	13,61
75	0	3321	3320,95	65,31	14,94
78	45	3372	3372,04	51,09	14,22
82	30	3409	3408,59	36,65	14,41
86	15	3431	3430,74	22,05	14,60
90	0	3438	3438,10	7,36	14,69
93	45		3430,74	7,36	14,72

This Table supposes a Radius greater than 3437,7, and less than 3438,4; according to Archimedes, the Radius would be between 3436,8, and 3438,5; mean 3437,4.

One may perceive that with the exception of some Sines, on which we only differ by a few tenths of a minute, the concordance is perfect in all the Table, whereas with the divisor 225, one would only obtain with approximate exactness the three first Sines, after which the error would increase with rapidity. I suspect that this erroneous divisor, is only a repetition of the divisor 225, which serves for finding the first of the first differences.*

The Indian author does not state how he has found his divisor, therefore it can only be verified by the fact. Now the fact demonstrates that he has employed a divisor very little different from mine.

That process is extremely curious: one finds nothing like it in the Trigonometry of Ptolemy, and in order to find some vestige of it, one must, after having vainly poured over all the authors on Trigonometry, come to Briggs, who knew that divisor, which he seems to have found out by the fact, in comparing the second differences obtained by other means; for Briggs himself was not aware that it was the Square of the Chord of the differential Arc $\triangle$ A.

But one may ask, why the Indians took $\triangle A = 3^\circ\ 45'$, instead of 1°. Here I believe follows the answer: it appears to me to have a considerable degree of probability.

There can be no doubt but that the Indians knew the following theorems, $\text{Sin}^2 A + \text{Cos.}^2 A = \overline{\text{Radius}}^2$; Versed Sine $A = \text{Rad.} - \text{Cos. } A = 2\ \text{Sin}^2 \tfrac{1}{2} A$: whence $\text{Sin } \tfrac{1}{2} A = (\tfrac{1}{2}\,\text{Rad.} - \tfrac{1}{2}\,\text{Cos. } A)^{\frac{1}{2}}$. Now these three theorems are sufficient for finding all the Sines of their Table, and can give none else—they have therefore achieved all that they could, and their Table shews the limits of their science. Indeed one sees at page 290, that they have really employed these three Formulæ for calculating that Table, and that they knew besides that the Sine of 30° is equal to half the Radius, which seems to leave no doubt on what I have said. Their Table thus constructed, they will have examined the first and second differences; and will have remarked that the first went on decreasing, but they will not have seen at first according to what law? The second differences on the contrary, went on increasing, and it was no difficult matter to discover that they were proportional to the Sines, for the second difference opposite to 30° is 7,36, and that opposite to 90° is 14,72, the double of the preceding one: and to find the ratio of the second difference to the Sine, they will have divided the Radius 3437,75 by 14,72, and found the quotient to be 233,53. Dividing thus every Sine by its second difference, they will constantly have found the same quotient, whence they will have concluded that in order to have the second difference, it suffices to divide the Sine by 233,53.

The Rule for the first differences is not so obvious, for the difference of $\text{Sin } A = 2\ \text{Sin } \tfrac{1}{2} A$, Cos. $(A + \tfrac{1}{2} \triangle A)$, and the Sines $(A + \tfrac{1}{2} \triangle A)$ are not in the Table.

But the first of the first differences, is at the same time the first Sine in the Table; from which they have concluded that with the first Sine, the first of the *first* and *second* differences, one had all that was necessary for calculating all the rest. But in truth the Table was already calculated when the Hindu computers gave their differential method, and the proof is, that to make their Table be such as they have given it, they had need to make the first Sine 224,85 and not 225, which would have given the first differences a little too great, and the Sines too small.

It is true that the Surriah Siddhanta directs to divide by 8 the number of minutes which is contained in one Sign, in order to have the first Sine, which comes to the same thing as taking the Sine to be equal to the Arc. Thus $\frac{30^\circ}{8} = \frac{360^\circ}{96} = \frac{21600'}{96} = 225' = 3^\circ\ 45'$, whereas the true value found by the three theorems, is only 224′,85. Observe that there is nothing conjectural in all this *but the reasoning*, which I suppose to be that of the Indian computer, for the Hindus had really all the knowledge which I ascribe to them. I do not pretend either that they used decimal fractions; it is with a view to shorten process that I *employed* these in reconstructing their Table of Sines, for it is well known that all their calculations are sexagesimal.

They might in taking proportional parts (the use of which was well known to them) extend their Tables to every degree of the circumference, but these interpolated degrees would have had Sines much less accurate, and they have preferred giving those which resulted immediately from their formulæ, and to preserve in all its purity the Table which was to serve for the computation of all the others; but they have given from degree to degree their Tables of Equation of the Center.

Their theory for calculating these Tables of Equations was incomplete and inexact; although they used Epicycles as well as the Greeks for computing the inequalities of the Planets, that Calculus was with them less exact than that of Ptolemy: they had introduced an empyrical Equation ill contrived enough, and they supposed that from 90° to 180° the same Equations returned in an inverse order. In that respect the Greeks were more advanced than the Hindus; their Trigonometry was more perfect, altho' that of the Hindus resembles ours most, and that the Hindus seem to have had some theorems unknown to the Greeks. These Tables of Equations, however defective, present nevertheless a curious consideration; which is, that in the explanation given of them by the Hindus, the differences of the Equations are proportional to the Sine of the Anomaly; or (what comes to the same nearly) that the variation of the Sine is proportional to the Cosine.

It will be found also in that Memoir, that the Hindus found the Latitude of a place by calculating the length of the Shadow of the Gnomon, particularly when the Sun was in the Equator: they might find it also by means, of the Solsticial Shadows on employing the greatest declination, which according to them was 24°.

For determining the Longitudes they observed the Eclipses and compared them to the computations made on the Lunar Tables constructed for their first Meridian.

At page 315 one sees how, by means of their Sines, and without knowing the Tangents, they computed the Sun's Right Ascension. Also how they computed the Ascensional differences and the point of the Equator which rose with each Sign of the Ecliptic. Their Table for the same was published by Le Gentil, who acknowledges not to understand upon what principles it is constructed; that principle is disclosed in the Memoir and I have commented upon it at full length in a Note.

We shall enter into no discussion on the antiquity of the Surriah Siddhanta (*). If we were only to consider the form of their Tables, their ideas on the precession of the Equinoxes, their Obliquity of the Ecliptic of 24°, and the theory of the Eclipses, we might suppose the Hindu Astronomical books to be more ancient than those of the Alexandrian Astronomers. On the other hand, finding that they possessed knowledge which is not to be found among the Greeks, one would be tempted to suppose them more modern. All that is common between them is the system of Epicycles for the Planets, but less perfect than that of the Greeks, from which circumstance one might conjecture that the doctrine of the Indians has passed into Greece, where it was extended and improved. It would be less natural to suppose that the Hindus have received from the Greeks, through the channel of the Arabs, theories which are to be found in their hands but in a crude and incomplete state. All that we can affirm is, that the Memoir under consideration without teaching us any thing that might advance our real knowledge, or serve to the progress of Astronomy, is nevertheless singularly curious for all Astronomers. What renders the reading of it somewhat difficult, is the great number of Hindu technical words preserved in the translation. One might have given a second version where an European idiom alone would have been employed, and I had some thoughts of undertaking it, but to do this with success I had need of some further notions, and researches for which I had no sufficient time.

[*Connoissance des Tems, Annee* 1808, *page* 447.

(*) A learned Englishman formerly assigned 3840 years of antiquity to that book from the Epoch when he wrote. Since that time (in A. D. 1799) he has reduced that number of years to 731, i. e. to the year 1268 of our Æra.

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FRAGMENT II.

On certain infinite Series collected in different parts of India, by various Gentlemen, from Native Astronomers.—Communicated by George Hyne, Esq. of the H. C.'s Medical Service.

I have stated in a Note at the foot of page 93 of the Key to the Siddhanta Chandra Mana, (article Hindu Gnomonics) that in Mr. Hyne's opinion the Hindus never invented the Series referring to the Quadrature of the Circle which were found in their possession in various parts of India; and that Mr. Whish, from whom he had obtained some of those which were communicated to the Madras Literary Society, after having first expressed a belief that they were indigenous, had subsequently reasons for thinking them entirely modern, and derived from the Europeans; observing that not one of the *Jyautish Sastras* who used these Rules, were capable of demonstrating them.

Since the time that I wrote the Note referred to, Mr. Hyne has done me the favour to communicate to me an account of the Series which had come to his knowledge; and I now lay the same before the reader in that Gentleman's own language, being well persuaded that it cannot fail to interest much all the votaries of science.

" MY DEAR SIR,

I have much pleasure in communicating the Series, to which I alluded in a former note to you, regarding the quadrature of the circle; and which some have supposed to have been invented by the Hindoos.

Let d be the diameter of a circle, and c its circumference: then the value of c may be obtained by any of the following formulæ.

$$(1)\ c = 4d - \frac{4d}{3} + \frac{4d}{5} - \frac{4d}{7} \cdots\cdots = 4d\left(1 - \tfrac{1}{3} + \tfrac{1}{5} - \tfrac{1}{7} \cdots \pm \frac{1}{2n-1}\right).$$

$$(2)\ c = 12^{\frac{1}{2}}d\left(1 - \frac{1}{3.3} + \frac{1}{5.3^2} - \frac{1}{7.3^3} \cdots \pm \frac{1}{(2n-1).3^{n-1}}\right).$$

$$(3)\ c = 2d + \frac{4d}{2^2-1} - \frac{4d}{4^2-1} + \frac{4d}{6^2-1} \cdots \quad 4d\left(\tfrac{1}{2} + \frac{1}{1.3} - \frac{1}{3.5} + \cdots \frac{1}{\overline{2n-3}.\overline{2n-1}}\right).$$

$$(4)\ c = \frac{6d}{2^2-1} + \frac{8d}{6^2-1} + \frac{8d}{10^2-1} \cdots = 4d\left(\frac{2}{1.3} + \frac{2}{5.7} + \frac{2}{9.11} + \cdots \frac{2}{\overline{4n-3}\ \overline{4n-1}}\right).$$

$$(5)\ c = 4d - \frac{8d}{4^2-1} - \frac{8d}{8^2-1} - \frac{8d}{12^2-1} \cdots = 4d\left(1 - \frac{2}{3.5} - \frac{2}{7.9} - \cdots \frac{2}{\overline{4n-5}\ \overline{4n-3}}\right).$$

$$(6)\ c = 3d + \frac{4d}{3^3-3} - \frac{4d}{5^3-5} + \cdots = 4d\left(\tfrac{3}{4} + \frac{1}{2.3.4} - \frac{1}{4.5.6} + \cdots \frac{1}{\overline{2n-3}.\overline{2n-1}.2n}\right).$$

$$(7)\ c = \frac{16d}{1^5+4.1} - \frac{16d}{3^5+4.3} + \frac{16d}{5^5+4.5} \cdots = 4d\left(\frac{4}{5.1} - \frac{4}{5.1+10.5^2} + \frac{4}{5.1+10.5^2+10.17^2} \cdots\right)$$

$$= \frac{16d}{5}\left(\frac{1}{4} - \frac{1}{\frac{1}{4}+\overline{2^2+1}|^2} + \cdots \frac{1}{\frac{1}{4}+\overline{2^2+1}|^2+\overline{4^2+1}|^2 \cdots + \overline{\overline{4n-1}|^2+1}|^2}\right).$$

All these series, are very easily derived from that, which expresses the arc of a circle in terms of the radius and the tangent.

Let z be an arc of a circle, of which t is the tangent; r being radius. Then, by the theory of functions, or, by the differential calculus, $z = r\,(t - \frac{t^3}{3} + \frac{t^5}{5} - \frac{t^7}{7} + \frac{t}{9} \cdots)$. If $r = 1$ and $z = 45°$, then $t = 1$; and $c = 8\,z = 4d\,(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} \cdots)$, which is the first series. If $z = 30°$, then $t = \frac{1}{3^{\frac{1}{2}}}$, and $c = 12z = 6d\,(\frac{1}{3^{\frac{1}{2}}} - \frac{1}{3\cdot3^{\frac{3}{2}}} + \frac{1}{5\cdot3^{\frac{5}{2}}} \cdots) = 12^{\frac{1}{2}}d\,(1 - \frac{1}{3.3} + \frac{1}{5.3^2} - \frac{1}{7\cdot3^3} \cdots)$, which is the second series. If the difference of each pair of terms of the first series be taken successively, then $c = 4d\,(\overline{1 - \frac{1}{3}} + \overline{\frac{1}{5} - \frac{1}{7}} + \overline{\frac{1}{9} - \frac{1}{11}} \cdots) = 4d \times (\frac{2}{1\,3} + \frac{2}{5.7} + \frac{2}{9\,11} \cdots)$, which is the fourth series: and, if we begin after the first term, then $c = 4d\,(1 - \overline{\frac{1}{3} - \frac{1}{5}} - \overline{\frac{1}{7} - \frac{1}{9}} \cdots) = 4d\,(1 - \frac{2}{3.5} - \frac{2}{7\cdot9} - \frac{2}{11\cdot13} \cdots)$, which is the fifth series. If the two last series, which are equal to each other, be added together, and each term of the sum be divided by two, then $c = \frac{4d}{2}\,(1 + \frac{2}{1.3} - \frac{2}{3.5} + \frac{2}{5.7} - \frac{2}{7\cdot9} + \cdots) = 4d \times (\frac{1}{2} + \frac{1}{1.3} - \frac{1}{3.5} + \frac{1}{5\,7} \cdots)$, which is the third series. If the terms of the following series $\frac{1}{4}\ \frac{1}{2\,4}\ \frac{2}{4.6}\ \frac{3}{6.8}\ \frac{4}{8\cdot10} \cdots$ be added and subtracted to and from those of the first, thus:

$$
\begin{array}{l}
\quad\ 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} \cdots \\
- \frac{1}{4} + \frac{1}{2.4} - \frac{2}{4\cdot6} + \frac{3}{6\cdot8} - \frac{4}{8.10} \cdots \\
\quad + \frac{1}{4} - \frac{1}{2.4} + \frac{2}{4\,6} - \frac{3}{6.8} \cdots \\
\hline
\frac{3}{4} + \frac{1}{2\,3.4} - \frac{1}{4\cdot5.6} + \frac{1}{6\,7\,8} - \frac{1}{8\,9\cdot10} \cdots;\ \text{then}
\end{array}
$$

$$(6)\ c = 4d\,(\tfrac{3}{4} + \frac{1}{2\,3\cdot4} - \frac{1}{4.5\,6} + \frac{1}{6\,7\cdot8} - \cdots).$$

(7) If the terms of the series $\frac{1}{5},\ \frac{2}{17},\ \frac{3}{37},\ \frac{4}{65},\ \frac{5}{101} \cdots \frac{n}{4n^2+1}$ be added and subtracted to and from different terms of the series $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7}$ — thus:

$$
\begin{array}{l}
\quad 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} \cdots \mp \frac{1}{2n-1} \\
- \frac{1}{5} + \frac{2}{17} - \frac{3}{37} + \frac{4}{65} - \frac{5}{101} \cdots \pm \frac{n}{4n^2+1} \\
\quad\ + \frac{1}{5} - \frac{2}{17} + \frac{3}{37} - \frac{4}{65} \cdots \pm \frac{n-1}{4\,\overline{n-1}|^2+1} \\
\hline
\frac{4}{5} - \frac{4}{255} + \frac{4}{3145} - \frac{4}{16835} + \frac{4}{9^5 + 4\cdot9} \cdots \mp \frac{4}{\overline{2n-1}|^5 + 4\,\overline{2n-1}}
\end{array}
$$

then $c = 4d\ \frac{4}{(1^5 + 4\cdot1} - \frac{4}{3^5 + 4.3} + \frac{4}{5^5 + 4\,5} - \frac{4}{7^5 + 4\cdot7} + \frac{4}{9^5 + 4.9} \cdots \mp \frac{4}{\overline{2n-1}|^5 + 4.\overline{2n-1}|}$), which is the seventh formulæ.

I am, my dear Sir, most sincerely, your's,

MADRAS, 17th August 1825.

G. HYNE."

⁂

FRAGMENT III.

On the Tamul Divisor of 576 *years*.—Text, page 8.

INDEPENDENTLY of what has been said in the Text and Commentary of the Divisor 576, I shall remark one of its peculiarities which has hitherto escaped attention.

It is sometimes convenient in the course of investigation, and particularly in cases where the juxta position of Epochs is required, to set off on one side from a Root free from fractions. Now the period of 576 years enables us to resolve the Problem with great ease, provided an Epoch whose Root is an integer, be given.

For if out of Table I, we take the *abstract* Root for 576 years (*) we will find it to be (4^d) 0^g 0^v 0^p, and as there are seven days in the week, on each of which the *Saura Mana* may begin, if we multiply 576 by 7, we have 4032 years for product, whose *abstract* Root by Table I is (0^d) 0^g 0^v 0^p. (†)

EXAMPLE.

Let the initial Root of A. C. 3330 *current*, or 3329 *complete*, be resolved, it will be,

3329—3102=A. D. 227.

		D.	G.	V.	P.
Epoch A. D. 200, Table IX, -	200	(1)	0	56	15
	20	(4)	10	25	0
	7	(1)	48	38	45
Initial Root A. C. 3330 complete -	227	(0)	0	0	0
Hence if to the Epoch A. C. 3329 - -		(0)	0	0	0
We add (or subtract) abstract Root for 576 years	±	(4)	0	0	0
We have - - - - -	Sum	(4)	0	0	0
	Difference	(3)	0	0	0

But if instead of the abstract Root for 576 years we use that of its multiple 4032 years, viz. (0^d) 0^g 0^v 0^p; it is manifest that the Epoch will remain as it was, relatively to the initial feria.

		D.	G.	V.	P.
(*) For the abstract Root for 576 years, Table I - -	500	(6)	20	25	0
	70	(4)	6	27	30
	6	(0)	33	7	30
Abstract Root	576	(4)	0	0	0
(†) For the *abstract* Root of the period of 4032 years we have, Table I, -	1000	(5)	40	50	0
				×	4
	4000	(1)	43	20	0
	30	(2)	45	37	30
	2	(2)	31	2	30
Abstract Root	4032	(0)	0	0	0

In the same manner, if there be any fraction in the proposed initial Root, or Epoch, the fraction in *both cases* will remain unaltered.

On this principle I have calculated the initial Roots of the following years, which exhibit every possible change which may occur where the generating Root or Epoch consists of integers only.

Generally, in the period of 4032 years the series of initial integer Roots in ascending progress will be 0, 3, 6, 2, 5, 1, 4, 0, &c. and in descending years 0, 4, 1, 5, 2, 6, 3, 0, &c.

This, however, is not to be mistaken for a Solar Cycle, excepting as far as the feriæ which begin the Solar years are concerned.

Years Saca complete	Years Caliyugam complete	Years Ante Christum.	Roots of Initial Feriæ.
		3304	0
		3228	4
	449	2652	1
	1025	2076	5
	1603	1500	2
	2177	924	6
	2753	348	3
		Anno Domini.	
150	3329	228	0
726	3905	840	4
1302	4481	1380	1
1878	5057	1956	5
2454	5633	2532	2
3030	6209	3108	6
3606	6785	3684	3
4182	7361	4260	0
4758	7937	4836	4
5334	8513	5412	1
5910	9089	5988	5

FRAGMENT IV.

Computation of an Eclipse of the Moon by means of certain memorial and artificial words, and of shells in lieu of figures; the formulæ for which refer to the four Vakiam Tables (the XXVIth, XXVIIth, XXVIIIth and XLVIIth) published in this collection.—By Sami Naden Sashia, *a Kalendar maker residing in Pondicherry.*

I had often read and heard of the singular process by means of which the common Indian Almanac makers computed Eclipses; scoring their quantities with shells, instead of writing them in figures; and dispensing with the use of Tables, by means of certain artificial words, and syllables; which recalled the required numbers and Equations to their recollection, and was long desirous to obtain a positive proof of the truth of that report, which I always suspected to be much exaggerated. After a long search for one of these mechanical computers, a person was introduced to me by my venerable friend Abbe Mottet (one of the Missionaries of the Institution *de Propaganda Fide* in this part of India), and I found the *Sashia* thus introduced to me, competent to my object, for (as I wished) he did not understand a word of the theories of Hindu Astronomy, but was endowed with a retentive memory, which enabled him to arrange very distinctly his operations in his mind, and on the ground.

This person, whose name was *Sami Naden Sashia*, computed before me the Lunar Eclipse which forms the subject of the present Fragment; and after a due examination of his process, I concluded (as indeed I had expected) that the artificial words which were supposed to elicit results, were only designed as vehicles for finding the arguments of the four Vakiam Tables published in this collection, and of some others not included therein, without which it would have been impossible for him to perform his task.

With regard to his calculating with shells and counters, (the latter representing zeros) it amounts to nothing more than scoring any number of points when playing at cards with similar articles, but on a larger scale. The multiplication and division of numbers, these computers abridge by means of particular Tables, generally constructed by themselves, which contain the number of multiples of the Elements which are likely to be wanted in the operation; so that in the first case, they find the product at once; and in the second, by help of the nearest quantity to the dividends they find the quotients in the adjoining columns, the operations being thus reduced to addition and subtraction.

The foregoing explanation may I believe, dispense me from representing all the figures resulting from the various dispositions of the shells in the different branches of the Problem, and admit of, my using figures in the more complicated part of this computation; this being necessary to avoid confusion in explaining the process; for there is no cancelling on paper, a rule which they cause to vanish by mixing the shells the instant that its results have been obtained; preserving only the latter for future application in a distant part of the ground on which they operate.

Numerical account of the Sounds.

1 Ka ; Tha ; Pah ; Ya or Yum ; Kiah ; wia ; Staha ; nnium.
2 Kha ; Thaha ; Paha ; Rra ; Kra ; Ra ; Ri.
3 Gheu ; Dheu ; Bheu ; la ; Kla.
4 Gaha ; Dhaha ; Baha ; Va ; Ve ; Koon.
5 Ghank ; Nanh ; Ma or Mon ; Na ; Sa.
6 Tsha ; Ta ; Tou ; Shah ; Utsha ; Cshe ; Recshe.
7 Tshaha ; Taha ; Saha ; Za.
8 Dja ; Deheu ; ha ; hi ; Dhena ; Do.
9 Djiha ; Dhaha ; Lhah ; Dha.
O. Gnia. Na. Ni. Rno. a. (the last, or *zero*, being always expressed with a counter.)

A near approximation to all these sounds is considered as included in the list, and therefore renders their articulation very numerous.

This variety of sounds for the same number was invented for the purpose of avoiding cacophony, when using them to express large quantities, wherein the same figure may be repeated several times; and also to give to the collected syllables the resemblance of a rational word.

When a regular *technical* term is too short to be split into as many syllables as the quantity which it expresses contains of digits, then they lengthen it at pleasure and construct by that means, a *memorial* word which answers their purposes. This will be exemplified in the following exposition of the Elements of the Vakiam process.

The Vedam, Ve—do—da—Gnia—na—tou—Staha.
The Raza Gherica, Ra—za—Gheu—ri—ca.
The Kalanilam, Ka—la—ni—la.
The Devaram, Dheu—va—ra.

These syllables they expound by inverting their arrangement, beginning with the last, and ending with the first; and scoring from the right, thus:

Staha • —tou •••••• — Na O — Gnia Θ — Dha ••••••••• — Do •••••••• — Ve •••• a Vedam, or 1600984 days.

Ka • —Ri •• — Gheu ••• — Za ••••••• — Ra •• a Raza Gherica or 12372 days.

La ••• — Ni O — la ••• — Ka • a Kalanila or 3031 days.

Rra •• — Va •••• — Deheu •••••••• a Devaram or 248 days.

As for the *Chandra Vakiam Dhurmavana*, because it varies on each day of a Devaram, the computer retains that Element *numerically* in his mind; and the three digits which it contains (and can never exceed) recal to his recollection one of the 248 artificial words, which he learnt by heart; the sounds of each of which indicates the Moon's Equation due to the *Druva* of the day computed for. Thus, as will appear presently, the *Chandra Vakiam* on the 20th Vyassei (Bengal Jyaishthá) being 129, the computer says unto himself, Di—wia—va—Ra—Dja, which inverting he finds in his memory,

Dja ∷∷ — Ra •• — Va ∷ — wia • — Di ∷∷ which indicates $8^s\ 21^\circ\ 18'$.

If it had been for a Vakiam of 101, it would be, Dja—no—ma—nuium—hi •, and by inversion hi ∷∷ — nuium • — ma ⁙ — no O.— Dja ∷∷ which gives $8^s\ 15^\circ\ 8'$, vide Table XXVI.

For the Ahargana *and* Soota dina.

We need not repeat here what was so fully explained in the body of this work on the subject of these Elements. As the Almanac makers make their computations periodically, the *Ahargana* of the preceding year, furnishes them the means of finding that of the Sun for the beginning of the succeeding one, which is done by adding $365^d\ 15^g\ 31^v\ 15^p$ thereto. And the absolute duration of each Solar month, such as given in Table III of this collection, (which they all know by heart) enables them to find that for any particular day in the year, without any formal computation.

As for the recurrence of the new Moons, most of them use a Cycle of 19 years, like that of Meton; and with regard to the Eclipses (both Solar and Lunar) I believe many of them have learnt from the Europeans the use of the Chaldaic period of 223 Lunar months, or 18 years and 10 days; and that they venture to compute on a probability that they will hit on the proper day. I suppose that their knowledge of that period is of foreign origin; for I see it mentioned no where in their Astronomy. *Certain it is however*, that the common *Tamul* Kalendar makers, do not trouble themselves about the Luni-solar *Ahargana*, and that in their computations of Eclipses, every thing rests on the Solar one. (*)

ARTICLE 1.

The computer having established that a Lunar Eclipse is likely to occur on the 20th day of the Solar month Vyassei (Bengal Jyaishthá) of the Chacra year *Parthiva*, being the 4926th of the Cali yug, and the 1747th since the birth of Salivahana, calculates his *Ahargana* as above described, and finds it to be $1799313^d\ 2^g\ 18^v\ 15^p$, which he expresses thus, with his shells.

Vide Table III of this collection.

(*) Sami Naden acknowledged to me, that he had learnt how to determine when an Eclipse was possible, from Christian Missionaries: but that there was nothing about it in his books.

and dividing the sum of days by 7, he finds that the last expired day fell on *Tuesday*, and the current one on *Wednesday*; because altho' they count the remainder after division from Friday as *zero*, for the *beginning* of the years and months, they reckon *Friday* as 1, for the intermediate days of the month.

If we want to find the European date of these, *Tuesday* and *Wednesday*, we may have recourse to the methods which were disclosed in the first part of the Key to the *Madhyama Saura manu*: and *Tuesday* will be found to fall on the 31st of May (20th), and *Wednesday* on the 1st of June 1825, (21st Vyassei).

ARTICLE 2.

For the Sun's apparent place.

The next step to be taken is, to compute the Sun's apparent place at his rising on the *Soota dina*, which was explained at full length at page 124 and following, (Key to the Siddhanta Chandra mana, Part II), and therefore need not be repeated here. I shall only give the abstract of the Rule, as follows:

1° The *Ahargana* for the 20th Vyassei, (besides the sum of days) gave a fraction of

	2^s	18'	15^p
which retrench from	60		
remainder	57	41	45

which *guddias*, *viguddias*, &c. are to be added as *calas*, *vicalas*, &c. to the Sun's Saura degrees. (*).

To proceed.

For the Sun's Saura place.

	s.	°	′	″	‴
2° On the 20th Vyassei the Sun had moved through one complete Sign (that of Mesha) - - - -	1	0	0	0	0
Take for 19 complete days - -		19	0	0	0
,, 57 guddias - -			57	0	0
,, 41 viguddias - -				41	0
,, 45 paras - -					45
Sun's *Saura* place at Sun-rise -	1	19	57	41	45

3° To equate which, we have by the *Yoghiadi* Table (XXVII) for the first 8 days in

Vyassei - - -	19 calas
Do. 2^d or 16 days - - -	21
And for 4 days that remain (½ of 22) - -	11
Sum	51

(*) Vide Note at the foot of Table XXVII, part I. But then here we are to take 19°, and not 20°, for the 20th of Vyassei; otherwise we would have to subtract 2′ 18″.

But we want for 2° 13′ 15″ less (page 337); therefore as we have 22° for 8 days, it is $\frac{22}{8}$ = 2° 45′ for 1 day, and 60′ : 2° 45′ :: 2° 18′ 15 : 6′ 20′, which retrenching from 51′ give the Equation sought 50′ 53″ 40‴ *subtractive.* ☉'s Sfura place - 1ˢ 19° 57′ 41″ 45‴

Equation - -	--		50	53	40
☉'s *Sputa Graha* sought	1	19	6	18	5

Article 3.

For the Moon's apparent place.

1º We are first to compute the Moon's *Druva*; which is performed as indicated at page 132 and 133 of the second Memoir; it being remembered that the common Kalendar makers perform their divisions and multiplications, by the help of Tables of multiples as stated at page 334 of this article; and the result in the present instance is 1 vedam; 16 *raza ghericas*; 0 *calanilam*, and 1 *devaram*, with a remainder of 120, being the *Chandra Vakiam Dhurmavanham.*—The four Elements they multiply into the respective Longitudes, as shewn at page 133, the products being as follows:

1 vedam - - -	7ˢ	2°	0′	7″
16 raza ghericas - -	2	24	50	40
No calanilam - -	0	0	0	0
1 devaram - - -	0	27	44	6
Chandra Druva -	10	24	34	53

which is to be equated by means of that operation which they call *Phala Trium Desentara*, (vide page 134, and Table XLVII.)

2º It will have been found that after having divided the *Ahergana* by the four Elements, there was a remainder of 120 days, which is the Argument of Table XXVI. Now these figures recal to the memory of the computer, the following artificial syllables.

Di—wia—va—ra—dja,—which being reversed and expounded

:::: Dja
•• Ra •••• Va
• Wia :::: Di

produce 8ˢ 24° 18′, which is the first part of the Equation required.

3º For the Equation of the *Desentara calas*, we are to refer to Table XLVII, and find that those due to the preceding month, *Chaitram* (Bengal *Vaisácha)* are 15′, always additive. And for the *Andra vicalas*, the same Table gives us for Vyassei, *itself* — 10″.

Now the odd degrees, minutes and seconds of the Sun's apparent place, being 19° 6′ 48″ (present page) multiply the same by - - - × — 10

you have - — 3ᶜ 11ᵛ 8

which, (as was explained at page 134), are to be subtracted from the *Desentara calas*, being the second Equation sought.

4º Lastly, for the *Madhya Gati vicalas*, we are to resort to the *Chandra Vakiam*, (or Argument of Table XXVI) 129. Referring to the said Table we find the Moon's *Sputa Gati*, or true motion, for that number of days - - - 826 calas

But the Sun's mean motion is - - - 791

Difference 35

and as for each *devaram* (248 days) elicited by the division of the *Ahargana* by the four Elements, there is an Equation of 32 tarparies or thirds, and as in the present case there was only one *devaram* in the results (page 337), we have 35×32‴ = 1120 tarparies = 18^v 40^t; and on account of 40^t say 19 vicalas, which is the third Equation required.

5º With these results we come to the following conclusion.

Moon's Druva		10ˢ	21°	34′	53″
Chandra Phala		8	24	18	0
Moon's approximate Longitude		7	18	52	53
Desentara calas (page 338) - 15′ 0″					
Andra vicalas (page 338) - — 3 11					
Equation - 11 49			+	11	49
Madhya Gati vicalas			+		19
Chandra Sputa Graha, 20th Vyassei		7	19	5	1

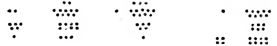
It is always to be understood that all these additions and subtractions are performed by the play of shells, which is very expeditious, but would have become tiresome if represented every time on paper.

Article 4.

For the Argument of the Purnima *Tidhi.*

This article is for finding the instant of opposition, which is always the end of the 15th Tidhi in the Lunar month. The operation consists in taking the difference of the Sun and Moon's Longitude, and then by the method indicated at page 137, to find the instant when it occurs *after that of true Sun rising*, on the particular day referred to, for which last article see also page 106.

These respective Elements the mechanical computer disposes, with his shells, in the following order.



Distance.	☽'s Longitude.	☉'s Longitude.
5s. 29° 53′ 13″	7 19 5 1	1s. 19° 6′ 48″

and proceeding as above stated, he finds that the instant of opposition occurred on the 21st Vyassei, at $0^{g}\ 30^{v}\ 0^{p}$ after true Sun rising at the place computed for.

It is not however, to be believed that the common Almanac makers calculate the *true* duration of the artificial day and night in the manner that was explained in the second section of the 8th article of the Key to the Siddhanta Chandra mana, the problems of which are far beyond their comprehension. They have a Table where the time of the Sun rising and setting for every day in the year, is ready computed; which serves them for a great number of years, and to which they refer the end of each Tidhi. When unable to construct it themselves, they procure one from their more learned colleagues.

Article 5.

For the apparent place of the Moon's Node, called Rahu.

Of the theory of this part of the Problem I could not obtain even the most general account; and circumstances of a painful nature, have prevented me from investigating it as I intended to have done. I give therefore the computation as I received it, with a belief however, that with the assistance of the data contained in this work, there will be no difficulty to demonstrate its several propositions.

1º The Tamul Almanac makers use a constant number, recalled to their memory by the sounds Csho—tha—na—Gnia—Rno—Recshe—yam, which inverted as usual gives

Yam—Recshe—Rno—Gnia—na—tha—Cshe

1 6 0 0 0 6 6

this number they subtract from the Ahargana (page 336) - - 1799313

(*) 1600066

Remainder 199247

2º They next put down this remainder in two places,

	1º		2º
	199247	Multiply the 2d by $\frac{1}{3}$ of the Periodical revolution of the Moon, or - -	199247
			× 9
(vide infra) -	- * 10 33 36 50		1793223
	199236 26 23 10		

3º This product is to be divided by another constant number recalled by,

Dhu—na—Dja—Dhu—tou—pum

which gives Pum—tou—Dhu—Dja—na—Dhu

1. 6. 9 8 0 9

(*) The daily motion of the Moon's Node being $3'\ 10''\ 45'''\ 6''''\ 52'''''$ or $3'\ 10''\ 45''',1446$ &c. if we suppose it to be in any point of the Ecliptic at the begining of a period of 1600066 days, it will be precisely 6 Signs behind its at the end of the same.

4° Proceeding to the said division, we have

169809) 1793223 (10 days
169809
95133
× 60
) 5707980 (33 guddias
509427
613710
509427
104283
× 60
) 6256980 (36 viguddias
509427
1162710
1018854
143856
× 60
) 8631360 (50 paras
8490450
140810
&c.

The quotient $10^d\ 33^g\ 36^v\ 50^p$ they put down under the shells which marked the first time 199247 * (page 340), and subtracting it from the same, they find a remainder of $199236^d\ 26^s\ 23'\ 10''$ (vide supra).

and this remainder they again divide by a number, recalled by the sounds, Cshe—tha—mum; which answers to Mum—tha—Cshe
5 6 6

In order not to confuse his shells, the computer performs that division in two or three steps, so as to bring out round numbers, as much as he can; thus

566) 199236 (350 signs
1698
2943
2830
Stop here - 1136
Then arrange the shells thus - - - 1136° 26° 23′ 10″
Multiply by 30 - - - × 30
34093 11 35 0

Divide again the degrees by 566) 34093 (60 = 2 signs, which add to 250 above found.
3396
Stop here - 133
× 60
7980
Add the minutes of the dividend - 11
566) 7991 (14′
566
2331
2264
67
× 60
4020
Add the seconds of the dividend - 35
566) 4055 (7″
3962
93 which neglect.

Hence we have a quotient of 352ˢ 0° 14′ 7″ of which retrenching the complete revolutions,

we have - -	4ˢ	0°	14′	7″
From 12 signs - -	12			
Supplement -	7	29	45	53
And add a Bijah of (*) -	-		40	0
Soota Rahu, or true place of ☊,	8	0	25	53

Article 6.

For the Patum Chandra Puram, *or Argument of the Moon's Latitude.*

1° Retrench Rahu's place from the Moon's, increased by 12 signs.

Moon's Sputa Graha, (page 339) - -	7ˢ	19°	5′	1″
	12			
	19	19	5	1
Soota Rahu ☊ -	8	0	25	53
	11	18	39	8
Take the Bhujah (page 86) - -	12			
Argument of *Vicshipa calas*, or minutes of Latitude -	0	11	20	52

2° With 11° refer to the *Vicshipa Pataca cala* Table here annexed, you find

	′	″
For 11° - -	51	32
Proportional parts for 20′ 52″ -	1	37
Nija Vicshipa calas -	53	9

which keep in reserve.

Table of Vicshipa Pataca cala.

°	′	″
1	4	43
2	9	26
3	14	8
4	18	51
5	23	32
6	28	14
7	32	55
8	37	40
9	42	19
10	46	53
11	51	32
12	56	8
13	60	43
14	65	19
15	69	54

Article 7.

For the Chandra Mandala Libitangula.

The Chandra *Vakiam Dhurmavanham*, which was found to be 129 days (page 338), when referred to Table XXVI, shewed that the Moon's true motion on the said devaram day was 826′.

1° Divide the same by - - - - - - - 25)826′(33′ 2″

75
76
75
1
60
25)60(2
50
10 which neglect.

The quotient 33′ 2″ is called *Chandra Mandala Libita.*

(*) The addition of these 40 calas in all computations of the place of the Moon's Node, by the Kalendar makers, appears to me manifestly empyrical, Put down this quotient in two places,

	1°	
	33′	2″
Multiply the 1st by	×	5
Halve it - ½ -	165	10
Carry it over - -	82	35 *

	2°	
	33′	2″
* Add	82	35
Halve it - - ½ -	115	37
Mana Yogarda Libita	57	48½
Subtract *Nija Vicshipa calas* (vide supra)	53	9
Grahana Libita, (Difference) which lay by -	4	39½

(N. B.—Here we have two sides of a right angled triangle, viz. the *Mana Yogarda Libita*, - - - - 57′ 48½″ or say 49″
And the *Nija Vicshipa Cala* - - 53 9
which keep in reserve.)

Article 8.

For the Csh'shna, *or quantity of the Disk eclipsed.*

Having found the difference of the above two Elements to be 4′ 39½″; or say 4′ 40″, we are to divide the same by the *Chandra Mandala Libita*, 33′ 2″ (1982″) found at page 342, for which purpose we are to raise that quantity by repeated multiplications into 60, until the latter may divide the former. $4' \times 60 + 40'' = 280''$ and $280'' \times 60 = 16800'''$

1982) 16800‴ (8,47 &c.
15856
9440 which neglect
7928 &c.

and the quotient is the *Csh'shna*, shewing that 8-60ths of the Moon's Disk will be eclipsed.

Article 9.

For the middle, beginning and end of the Eclipse.

1° Square the *Mana Yogarda Libita*, 57′ 49″ (*Tamul* process).

1°	2°	3°	4°
57	49	57	49
57	57	49	49
399	343	513	441
285	245	228	196
3249	2793	2793	2401

Divide the 4th product by 60) 2401 (40
1

Add the quotient to the 3d - 2793
40
2833

Add the 3d - - - - - - 2793

Divide by - - 60) 5626 (93.46
226
46

Add the quotient to the 1st - 3249
93 46

Mana Yogarda Vurga - 3312 46
the square of 57′ 49″.

2° Square the *Nija Vicshipa Cala* 53′ 9″.

1°	2°	3°	4°
53	9	53	9
53	53	9	9
159	477	477	81
265			
2809			

Divide the 4th by 60) 81 (1
21 which neglect

Add the quotient to the 2d.
477
1
478

Add the second - 477
60) 955 (15′ 55″
355
55

Add the quotient to the 1st - 2809°
15 55

Vicshipa Cala Vurga (*) - 2821 55

3° For the *Moola Vurga*, or square of the third side of the triangle.

From the *Mana Yogarda Vurga* -	3342°	46′
Subtract *Vicshipa Cala Vurga* - -	2824	55
Moola Vurga -	517	51

4° Find the square root of the *Moola Vurga*, (*Tamul* process.)

		(*) 4	(†) 4
		(‡) 4	(*) 6
	Single.	Double.	Single.
Dispose the figures with shells thus - - -	5	1	7
Say 2×2=4	— 4		
Place the product under 5, and over 1 (*) subtract the latter. (x) Place the quotient 80 after division of 100 under 117, and subtract	1	1	7
		— 8	0
		3	7
Subtract			— 4
		3	3

Of 117 that remain divide 100 by 40 (because 4 * is placed in the column of tenths).
40)100(2×40=80
20
Add 17
Sum 37 (x)
Say again 2×2=(†) 4 which place at top in the column above 7, and under 7 below, from which subtract.

Multiply the remainder 33 by 60; and add to the product the 51 odd vicalas, i. e. 33×60+51 =2031″, which divide by 44 expressed at the top of the Rule (* and †).

44)2031(40
1760
Stop here - 271

(*) The 1st square by the European rule is 3342° 46′ 1″, the 2d 2824° 55′ 21″, and the square root of the 3d is 22′ 44″ 11‴, the difference proceeding from the Hindu rule neglecting the last fractions.

For the quotient 40 place 4 (‡) in the column at top between (*) 4 and 1.—Square the last quotient 40×40=1600, which divide by 60)1600(26′ 40″, and because the fraction 40 exceeds 22 (the half of the divisor 44) take 27.
40

From the preceding remainder -	271
Subtract these 27 - -	27
Sum	244

Which divide again by 44) 244 (5 24
220
24

and because the remainder exceeds 22, take 6 (✳), which quotient place at top in the column between (†) 4 and 7.

Lastly, take the half of 44 (* and †) which amounts to 22, then the *Moola Vurga Meta*, or the square root of the curtate distance, or *Mana Yogarda Labita* (page 343) is 22 calas, 46 vicalas, which lay by (vide note page 344.)

ARTICLE 10.

For the Grahana Tinooria Padhi, *or half the duration of the Eclipse.*

We have already seen (page 342) that the Moon's true motion for 129 days of a *devaram* was - - - - - -	826 calas.
And the Sun's true motion on the 20th Vyassei by Tamul account (*) is -	57 15
The relative motion is therefore - - -	768 45
or in vicalas -	46125″

Now as we are to divide the *Moola Vurga Meta* 22′ 46″, by the Sun and Moon's relative motion, raise it by repeated multiplication into 60, so that it may be divided by the latter, that is 22 × 60 + 46 × 60 = 81960.

Then 46125) 81960 (1 guddia
46125
35835
60
) 2150100 (46 viguddias
184500
305100
276750
28350
60
) 1701000 (36 paras
138375
317250
276750
40500 which neglect,

and the quotient is the half duration of the Eclipse, viz. 1^{g} 46^{v} 36^{p}.

(*) The Sun's true motion on the 20th Vyassei, by Table XXVIII, is 57′ 11″.

ARTICLE 11.

For assigning the time of middle, beginning and end of the Eclipse.

It was stated at page 340, that the Purnima Tidhi ended on the 21st of Vyassei at 0^{g} 30^{v} after true time of Sun rising. Now by the Tables which give the duration of the artificial days and nights for every day in the year, it appears that the duration of the day is - 31^{g} 35^{v}
20th to 21st Vyassei. Of the night - 28 25

28^{g} 25^{v} mark therefore the true instant after Sun setting when he rises again. But the Purnima Tidhi ended (the instant of opposition, page 340) at - 0^{g} 30^{v} after ⊙ rise.
Let it therefore be added to - - - - 28 25
End of Tidhi from preceding *Sun set* - 28 55 after ⊙ set.

End of Tidhi - - - - - -	28^{g}	55^{v}	0^{p}
From which retrench *Grahana Tinooria Pudhi* (page 345) -	1	46	36
	27	8	24

Beginning of Eclipse on the 20th Vyassei after Sun set 27^{g} 8^{v} 24^{p} after Sun set the preceding evening.

	G.	V.	P.
To the time of beginning - - -	27	8	24
Add 2 × 1^{g} 46^{v} 36^{p} - - - -	3	33	12
	30	41	36
But the Sun rose on the 21st at - - -	28	25	0
	2	16	36

therefore the time of end of Eclipse on the 21st after Sun rise is, 2^{g} 16^{v} 36^{p}.

CONCLUSION.

Hence the Phases, or *Calas*, of the Eclipse under consideration, are as follows:

Beginning 20th Vyassei -	27^{g}	8^{v}	24^{p}	after Sun set.
Middle 21st do. - -	0	30	0	after Sun rise.
End do. do. - -	2	16	36	after do.

Digits eclipsed 8.60ths of the Moon's Disk.

ARTICLE 12.

The Phases of the Eclipse as computed by the Tamul Formulæ, compared to the same calculated for the Meridian at Madras according to the European method.

We have seen (present page) that the duration of the night from the 20th to the 21st Vyassei, answering to that of the 31st May and 1st June 1825,

	Indian time.		European time.	
was - -	28^{g}	25^{v}	11^{h}	$22'$
The half of which is - -	14	12½	5	41

which indicates that according to the Hindu account, the Sun rises on the 21st Vyassei at 5ʰ 41′ A. M. (*)

	G.	V.	P.	H.	′	″	‴
To the time of Sun rising - - -	14	12	30	5	41		
Add that wanting from the end of Purnima Tidhi (page 340)		30	0		12		
Middle of Eclipse -	14	42	30	5	53	0	0
Add and sub. ½ duration (page 346) ∓ -	1	46	36		42	38	24
Beginning of do. -	12	55	54	5	10	21	36
End of do. -	16	29	6	6	35	38	24

which furnishes the following comparison.

	European.		Tamul.		Difference.
	H.	′	H.	′	
Beginning -	5	15	5	10,35	4′,25
Middle -	5	30	5	53,00	23,00
End -	5	44	6	35,63	51,63
Digits -	12^{d}	$30^{m\prime}$	8^{d}	$28^{m\prime}$	$4^{d}\ 2^{m\prime}$

Observation.

When it is considered how very coarse and undefined as to the place for which the Eclipse is computed, the process used by the Tamul mechanical computers undoubtedly is, it is really surprising that these results should come no wider from the truth. It is not however, to be believed that they are always equally successful in their predictions, and that the people who are bound to religious observances when these phœnomena recur, are never disappointed in their expectations. I recollect a circumstance which occurred not many years ago, when an Eclipse of the Moon had been announced for a certain evening in the Madras Panchangum; in consequence of which crowds of people had resorted to the Beach for performing their ablutions; but no Eclipse appeared; a circumstance which in China might have endangered the mistaken Astronomer's life, but with the gentle Indian, only occasioned a good deal of noise; and with a few, some merriment on his ill proficiency. The case I refer to may have proceeded from the ignorance of the *Sastra*; but it is certain (and will be readily believed) that even where the most skilful Astronomer is employed, no reliance can be placed on those raw predictions which are never certain within several hours of the time when an Eclipse is to occur.

It was originally my intention to have added an example of a Solar Eclipse to the foregoing one; but family afflictions, and want of health, have prevented me from further gratifying the reader's curiosity with disclosures of Indian mysteries.

(*) The Sun rises at Madras on the 1st June at 5h. 39′, the difference of the two accounts is therefore 2′.

I shall therefore, take a final leave of the *Kala Sankalita*, and trust it to it's fate with all it's imperfections; taking this last opportunity for expressing my gratitude to the Supreme Government of India, to those of Madras, Bombay, and Prince of Wales' Island, for having, whilst the edition of this work was in progress, manifested by public acts, their approbation of the author's *intentions*, and perseverance, in a pursuit in which he only engaged from a sincere and unaffected desire of paying a tribute of respect, (which he thought might prove acceptable) to a Government in whose service he has spent the most active part of his life.

THE END.

A

GLOSSARY AND INDEX

OF THE TERMS

OF

HINDU ASTRONOMY

USED IN THE

KALA SANKALITA.

Written in the year 1825.

⁂ *When looking in the Glossary for the explanation of a term used in the Text, or in any other book of Hindu Astronomy, it may so happen that the orthography has been altered in such a manner in the former that it is not to be found exactly where it otherwise should be. In such a case the reader will remember that according to Sir William Jones' system, the letter C is generally sounded hard: but should this consideration prove insufficient, he must then look for a word, the sound of which comes nearest to that of the term which he is seeking.*

A GLOSSARY AND INDEX

Of the terms of Hindu Astronomy used in the Kala Sankalita, *and in some other books treating of Hindu Astronomy.*

THE accompanying Glossary is the indirect, though necessary result of the investigation which constitutes the subject of this work. As it was not compiled by design, and as the terms which appear in its columns were gathered from various books, consulted only with reference to the task which the Author had undertaken, this Appendix can boast of no real importance *as a Collection*. But if it be considered as a Key to the Text, and as an exposition of the variations in its orthography which were occasioned by the introduction of Sir William Jones' system (now generally followed in Madras), it may prove of great assistance to the reader, not only for perusing these Memoirs, but any other book of Hindu Astronomy.

If it be considered that six and thirty years have hardly elapsed since we possessed any sound knowledge of the principles of that science;—that during the said space of time, it was only cultivated by five or six Gentlemen, most of whom were ignorant of the *Sanscrit* language, and who were widely dispersed over the immense territory subject to the British power in India, in every part of which a variety of idioms are spoken, no one will wonder to find so much dissimilarity in the manner of spelling terms which apply to none of the civil concerns of life, and several of which, many of the Natives of India never heard pronounced in the course of their lives. Nor can it be a matter of surprise if in many instances there remains still doubts in the minds of the learned of all countries, on the legitimate signification of certain technical terms, expounded by us, in this distant part of the world, when they see in Bengal the learned Colonel Dow write *Obatar Bah* (the name of the fourth Véda). what the Pundits of Madras spell *Athara véda*. (*)

The Author has incautiously ventured to affirm in a note introduced at the foot of page 70 of the Text, that he has followed the orthography of Sir William Jones, Mr. Davis, and Mr. Scott; but he was not then sufficiently aware that these Gentlemen are far from having followed the same system; nay, that each of them did not in all cases write the same word alike. There is certainly a very sensible difference between the sounds elicited by the orthography of the term of *Arca Baghabala* and *Arcabahu phala;* and yet both bear the same signification according to the above authorities.

As for those terms which the Author learnt immediately from his native instructors, and which form a considerable part of this collection, he feels bound to declare that he is totally ignorant of the Sanscrit language, and that those technical words which he was the first to expound, were

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(*) Vide Dow's Hindustan, vol. I, dissertation page xxix.

conveyed to his ear, by interpreters either *Telugu* or *Tamil*, whose pronunciation of foreign idioms is known to be very defective. The exact meaning of a word so presented to him, he could not expound according to the common process of *etymology*; he could therefore only discover it, either from the nature of the operation in the course of which it was employed, or by its affinity to other words in some of the living oriental languages: but it was not until the whole of this work was actually printed, that he succeeded in procuring competent judges, and obtained adequate means for correcting his orthography. He trusts therefore, that the frequent variations, and seeming inconsistencies which will be noticed in the Text and Glossary, will not be ascribed to neglect.

With respect to the principal article, namely, the signification of the terms, the Author declares that he has not introduced a single exposition which did not come right home to his comprehension, either as to sense or application; and that he has borrowed none but from authentic and approved authorities.

In some few cases the Author and the *Pundits* whom he consulted, could not come to an understanding either as to the existence, or signification of a particular term; generally he relinquished the dubious expression when it was of little importance: but when he had cause to be satisfied that his sense of it was well established, he thought it his duty to persist, and insert it in his catalogue; but then the contested term is indicated by an asterisk.

In the arrangement of the articles it was found sometimes indispensable to follow the *objectionable* orthography in the leading column, because a different course would have perplexed too much the references; particularly in the use of the letter C, which (according to the system of Sir William Jones) supersedes in all cases the, sometimes, more appropriate K. For who would look for an explanation of the term *Kendra* in the right column, if (notwithstanding all warnings) it were announced to the eye by the word *Cendra?*—But the true spelling has always been observed in the Gloss, although it be not at all unlikely that the *wrong* orthography, more readily than the *right* one, would recal the term under consideration, to the recollection of a *Telugu*, or *Tamil Sastri*.

A GLOSSARY AND INDEX, *&c.*

(N. B.—The Arabic figures refer to the pages of the Text, and the Roman to those of the Preface and Chronological Tables, being distinguished by Pr. and Chr. Table prefixed to each.—The Letter C is to be pronounced hard in all cases.)

A

ABHIJIT, (అభిజిత్)—The extraordinary *Nacshatra*, or Lunar mansion. When Astronomers, or Astrologers, have occasion for this, they insert it between the 21st and 22d Nacshatras, in which case they take 3° 20′ from *Uttara A'shad'ha*, and 1° 40′ from *S'ravan'a;* thus making it consist of 5°. It is chiefly used for Astrological purposes. Vide p. 309.—*Abhijit*, as a *Yoga* (or leading Star of a Lunar mansion) is the same as *α Lyræ*. Vide p. 73, 74.

A'CAS'A, (ఆకాశ)—A name for the Sky, or Firmament.

ACSHA, (అక్ష)—Terrestrial Latitude.—*Acsha-ansa*, and *Acsha Bhagas*. Degrees of.—*Acsha Carna;* Hypothenuse; but in its Astronomical sense, means what Europeans call the *Argument of the Latitude*, as well as *Patana Céndra*. Vide from p. 94 to 96, and Tab. XXXIII, p. 44 of the Tables.

ADIGAH, (అధిక)—(so wrongly spelt in the Text, but properly) *Athi*, or *Athica*.—When this word is prefixed to the name or numeral of a Luni-solar year, it implies that it is *embolismic*, or of 13 Lunar months. Thus *Athica Samvatsara* means an intercalated year. Vide p. 71.—When to the name of a month, it indicates an intercalary one. Hence *Athica masa* means an intercalated month. Vide p. 71, 72.—And lastly, to the name of a Lunar day or *Tithi*, that it is repeated on two consecutive days in the Kalendar. Vide p. 72; also p. 65, 67, 68, 142, and Table XXIX.

A'DITYA, (ఆదిత్య)—An epithet given to the Sun; meaning the *Attractor*.—Such a designation given by the Indians to that great luminary, may give rise to conjectures and speculations in the mind of the natural Philosopher.

AGASTYA, (అగస్త్య)—The Star *Canopus*.

AGNI SAVARNI, (అగ్నిసావర్ణి)—One of the 14 Patriarchs who preside successively over the 14 *Manwantaras* of *the Calpa*. Vide p. 311.

AGRA, (అగ్ర)—Amplitude. *Agra Bhagas;* degrees of. Vide p. 91, 101.—*Agrajya*, sine of the Amplitude. Vide p. 102.

AGRAHA'YANI, (ఆగ్రహాయణి)—(written *Agrahayan* in the Text)—A new name given to the Solar month *Margás'iras*, when the latter was made to commence the year.—This event is supposed by some to have occurred 698 years before Christ; when, according to the same authorities, the *Ayanansa* was accounted to be 6° 40′. Vide p. 5, 215, and article *Ayanansa.*

AHA'RGANA, (అహర్గణ)—The number of days from a given Epoch, to the time for which a computation is made. Vide Pr. p. vii; Text, 8, 9, 53, 171, 239, 241, 336, and Table XLI.—N. B. The term *Ahárgana*, is not used to express the number of days expired since the epoch of the creation. (See Strostidi Digona).

AHAS, (అహస్)—The length of the artificial day. Vide p. 313, 318.

ALIPALA, (అళిఫల)—The 1.60th part of a *Casta'calá.* Vide p. 6.

AMA'VA'SYA, (అమావాస్య)—The conjunction of the Sun and Moon, also called *Arcéndu-Sangama* (written in the Text *Arca-Indu)*—*Ama*, and *Darsa* Tithi, are other names given to the Lunar day, on which the conjunction occurs; which in the Kalendar is always reckoned the 30th of the Lunar month. Vide p. 68, 70, 137.—*Amávásya Tithi*, the lunar day of the Moon's change. Vide p. 78, 108.

AMRĬTA, (అమృత)—The water of immortality, obtained by the churning of the ocean, and the occasion of the war between the *S'uras*, and *As'urás*, in which the gods took a part. This indicates the occurrence of the first Solar Eclipse on Indian record. Modern European commentators conjecture that it fell on the 25th October in the year 945 before Christ.

ANALA, (అనల)—The name of the 50th year of *Jupiter's* cycle of 60 years. Vide I Chr. Table.

A'NANDA, (ఆనంద)—The name of the 48th year of the same cycle. Vide do.

ANANTA, (అనంత)—*Infinity; Eternity; Time;*—also, the King of the Serpents.

ANANTA S'AYANA, (అనంతశయన)—Travancore. Vide Table XXXIII, p. 41 of the Tables.

ANGA'RACA, (అంగారక)—One of the names of the Planet *Mars.*

A'NGIRA, (ఆంగిర)—The 6th year of the cycle of 60 years. Vide I Chr. Table.

ANGULA', (అంగుళ)—A digit, or 1-12th part of any dimension; subdivided into 60 *vyangulas.* Vide p. 92, 94.—*Libit angula*, digits obscured in an Eclipse. Vide p. 342.

AN'SA, (అంశ)—Degrees (Vide *Bhaga*). Also the numerator of a fraction.

ANURA'DH'A, (అనూరాధ)—The 17th Lunar mansion. Vide p. 71.

ANTARA, (అంతర)—(written *Andra* in the Text)—An intermediate space, a difference in computations.—*Antara vicalas*, surplus seconds. Vide p. 131 and Table XLVII, p. 63 of the Tables.

ANTERA, (అంతర)—Last.—*Prathama, Madhya,* ANTERA. *First, mean,* LAST. Vide p. 103 referring to the *Chara cumda.*

A'RAMBHA, (ఆరంభ)—Beginning.

ARCA, (అర్క)—One of the names of the Sun.

ARCABA'HU PHALA.SANSCARA, (అర్కబాహుఫలసంస్కార)—In some Mss. *Arcabhagabala* (and written in the Text, *Arca bahoota* and *Arcabaghabala)*—The arc which a Planet describes during that part of the equation of time, which arises from the inequality of the Sun's motion in his orbit: being an equation to which all the Planets are subject, but the motion of which it differently affects. Vide p. 87, 88, 184, 185, 190, and Table XXVII, part 2, p. 35 of the Tables.

ARC'ENDU SANGAMA, అర్కేందుసంగమము)—The instant of true conjunction of the Sun and Moon. Vide p. 70.

AR'DHA, (అర్ధ)—The half.—*Dina ardha*; half the day: *Ratri arda;* half the night. Vide p. 106.

AR'DRA, (ఆర్ద్ర)—The 6th Lunar mansion. Vide p. 74.

ARPESI, (అర్పిశి)—The 7th month of the Solar year, Tamil denomination, answering to the Hindu month *Cartiga* during which the Sun is in the Sign *Tula* ♎. Vide p. 5, and Table III, p. 3 of the Tables.

A'RYA BHATTA, (ఆర్యభట్ట)—A celebrated Hindu Astronomer who flourished in the 4423d year of the *Cali yug*, answering to A. D. 1322. He left several Mathematical tracts, some particularly relating to the properties of the Circle.

ARYA SIDDHANTA, (ఆర్యసిద్ధాంత)—A treatise of Astronomy, composed by *A'rya bhatta*, of which there is a spurious one. There is some variation in the copies of this work preserved in Bengal and in the Carnatic, the former making the Solar year 365D 15d 31p 17c 6‴, the latter 365d 15g 31v 15p; and the Lunar Synodical month, the former 29d 31g 50v 6p 7s,84, &c. and the latter 29d 31g 50v 5p 40s,21, &c.—N. B. The copy used in this work is that of the Carnatic. Vide p. 7, 66, 118, 199, 203, 239, and Tables XLVIII and XLIX, p. 63 and 64 of the Tables.

ARUNA, (అరుణ)—The dawn, or *Aurora*, mythologically the *Charioteer* of the Sun.

A'SHA'D'HA, (ఆషాఢ)—*Purva* the 20th, and *Uttara* the 21st Lunar mansions. Vide p. 74.—The 4th Lunar month. Vide p. 69.

A'SHA'D'HA, (ఆషాఢ)—The 3d Solar month, Hindu denomination, when the Sun is in the Sign *Mid'huna* ♊, answering to the Tamil month *Audi*. Vide p. 5, and Table III, p. 3 of the Tables.

AS'LE'SHA, (ఆశ్లేష)—The 9th Lunar mansion. Vide p. 74.

ASTA, or ASHTA, (అష్ట)—Eight.—*Asta' dic.* The 8 points of the compass, including the cardinal ones.—N. B. This word is wrongly interpreted at page 92, where the *Asta Dikus* are stated to be the 4 intermediate divisions of the compass.

ASTAMI, or ASHTAMI, (అష్టమి)—The 8th Lunar day of the *Pacsha* or demi-lunar month. Vide p. 70.

AS'URA' DHRUVA, (అసురధ్రువ)—The South Pole.

ASURAS, (అసురా)—Its inhabitants, opposed to the Súras, those of the North Pole.

A'S'WINA, (ఆశ్విన)—The 6th Solar Hindu month, when the Sun is in the Sign *Canya* ♍, answering to the Tamil month *Parutasi*. Vide p. 5, and Table III, p. 3 of the Tables.

AS'WINI, (అశ్విని)—The first Lunar mansion. Vide p. 74.

ATHARAVANA' or **ATHARA VEDA,** (అథర్వణ)—The fourth of the inspired *Vedas.* This book comprehends the whole science of Theology, Metaphysics and Philosophy.

ATCHU, (అచ్చు)—A term used by Father Beschi after the Southern Astronomers, to signify an Epoch.

ATIGAND'A, (అతిగండ)—The *Yoga* Star of the 6th Lunar mansion, perhaps the 133d of *Taurus,* but very uncertain. Vide p. 74.

AVANTI, (అవంతి)—Supposed to be the ancient name of *Ujáni* or Oogein. Vide p. 9.

AVATA'RA, (అవతార)—Descents of the Deity in various shapes, and under various names, of which *Rama,* and *Crishna* are the most remarkable. Vide p. 311.

AUDI, (ఆడి)—The 4th Solar month, Tamil denomination, answering to the Hindu *Srávaná,* when the Sun is in the Sign *Carcáta* ♋. Vide p. 5, and Table III, p. 3 of the Tables.

A'UNI, (ఆని)—The 3d Solar month, Tamil denomination, answering to the Hindu *A'shar,* when the Sun is in the Sign *Mid'huna* ♊. Vide p. 5, and Table III.

AVA'MATHA, (అవమాహ)—A term used in the Kalendar for expressing an expunged *Tithi,* or Lunar day. Vide p. 72, 319.

AVANI, (ఆవణి)—The 5th Solar month, Tamil denomination, answering to the Hindu *Bhádra,* when the Sun is in the Sign *Sinha* ♌. Vide p. 5, and Table III.

AYANA', (అయన)—A name applied to the Equinoctial, and Solstitial points.—*Mésha Ayaná ; Tula Ayaná ;* the Vernal and Autumnal Equinoxes.—*Uttara,* and *Dacshin'a Ayaná ;* the Northern and Southern Solstices.—*Ayaná Bhagas,* (vide Ayanáns'a)—*Ayaná Cála*; the time from an Equinox to the ensuing one. Vide p. 4, 76, 77, 308.

AYANA'NS'A, (అయనాంశ)—The arc between the Vernal Equinoctial point, and the beginning of the Solar Sydereal (or fixed) Zodiac (or the first point in the Solar Sign *Mésha* ♈), being one of the most important elements of Hindu Astronomy, as it refers the Sydereal, to the Tropical Zodiac. (Vide *Cránti-Pata-Gati-Rishis*). Vide also Pr. p. x, Text p. 19, 76, 84, 183, 246, 247, and Tables XXXV and XXXVI, p. 46 and 47 of the Tables.

A'YUSHMAT, (ఆయుష్మత్)—The *Yoga* Star of the 3d Lunar mansion, *Alcyone.* Vide p. 74.

B

BAD'ABA'NALA, (బడబానల)—A name sometimes applied to the South Pole.

BAHUDANYA, (బహుధాన్య)—The 12th year of Jupiter's cycle. Vide Chr. Table I.

BA'LADITYACALU, (బాలాదిత్యకలు)—(spelt in the Text Bulla dutty callu)—A Telugu Astronomer who wrote in the 4558th year of the Cali yug. Vide p. 9.

BALARAMA, (బలరాము)—The 8th Incarnation of *Vishnu* as a *Cshetriya*, the anniversary of which is noticed in the Kalendar. Vide p. 311.

BALAVA, (బాలవ)—The second *Carana*. Vide p. 75.

BAVA, (బవ)—The first *Carana*. Vide p. 75.—Also the name of the 8th year of the cycle of Jupiter. Vide I Chr. Table.

BHAGAH, (భాగః)—An arc equal to the 1-360th part of the circumference of a Circle; or one degree. Vide p. 77.—*Bhaga-Anubanda*, or *Apavácha*; an infinite series. Vide p. 93.

BHAGAN'A, (భగణ)—The circumference of a Circle.—Independently of Astronomical purposes, the Indians frequently divide the circumference of the Circle into 12 *Ras'is* or Signs, subdivided sexagesimally into *Bhagas*, *Calás*, *Vicalás*, &c. i. e. degrees, minutes, seconds, &c., vide p. 85.—*Bhagan'a* means also a revolution.

BHA'DRAPADA, (భాద్రపద)—*Parva* the 25th, and *Uttara* the 26th Lunar mansions; vide page 74.—The same word, or merely *Bhádra*, is the name of the 5th Solar Hindu month, answering to the Tamil *Auvani*, when the Sun is in the Sign *Sinha* ♌. Vide p. 5 and Table III, also p. 232.

BHAGAVATA, (భాగవత)—An historical book, reckoned authentic.

BHANU, (భాను)—A name or epithet of the *Sun*.—*Bhanu Husputtia Chandra mana*, or properly *Barhuspatya mana*. Vide *Mana*, also p. 148.

BHARAN'I, (భరణి)—The second Lunar mansion. Vide p. 74.

BHA'SCARA, A'CHA'RYA. (భాస్కరాచార్య)—An Indian Astronomer who wrote a commentary on the Arya Siddhanta. He is stated in Hindu books, to have flourished in the 4252d year of the *Cali yug* (A. D. 1150); but it is known that he was posterior to *A'rya bhattá* who wrote his treatise in A. D. 1322.

BHAUCHYA, (భౌచ్య)—One of the 14 Patriarchs who are supposed to preside successively over the 14 *Manwantaras* of the *Calpa*. Vide p. 311.

BHAUMA, (భౌమ)—One of the names of the Planet *Mars*.

BHRĬGU, (భృగు)—A name of the Planet *Venus*.

BHU', (భూ)—Seems to imply the middle place.—*Bhú chacra*, when applied to the Celestial Sphere, means the Equinoctial line.—*Bhú carná*, the Radius of the Equator.—*Bhú paridhi*, the same as *Bhú chacra*.

BHUDRA, or VUSTI, (భద్ర)—The 7th ordinary *Carana*. Vide p. 75.

BHUJA, (భుజ)—Is an astronomical argument, peculiar to Hindu astronomy; it is to be considered as follows: 1º If the arc exceeds 3 Signs—subtract from 6 Signs. 2º If it exceeds 6 Signs—subtract 6 Signs therefrom. 3º If it exceeds 9 Signs—subtract from 12 Signs; vide p. 85, 86, 114.—*Bhujajya*; the sine of the *Bhuja*.

BHU'MI, (భూమి)—The Terrestrial Globe, supposed to be in the center of the universe.—*Bhumi sávana*;

proper, natural to the Earth.—*Bhumi sávana dina*; a natural day. Vide p. 5, 78, 79, 101, 106, 239.

BI'JA, (బీజ)—(sometimes written *Beejah* in the Text).—An equation or correction. Vide p. 38, 84, 199.

BORNA COTI, (బౌర్ణకోటి)—The third imaginary city, supposed to lie under the Equator at 90° from *Lanca*. Vide p. 9.

BRAHMA, (బ్రహ్మ)—The first person of the Hindu triad, and the Creator of the world: no direct worship is addressed to *Brahma*; and no temples are dedicated to him.

BRAHMA A'CHA'RYA BRAHMA GUPTA, (బ్రహ్మాచార్య)—Supposed by some to be one and the same Astronomer, aad the inventor of the system disclosed in the *Súrya Siddhánta*—by others to be two distinct commentators of that *Sastra*.

BRAHMA SA'VARNI, (బ్రహ్మాసావర్ణి)—One of the 14 Patriarchs who are supposed to preside successively over the 14 *Manwantaras* of the *Calpa*. Vide p. 311.

BRAHMA SIDDHA'NTA, (బ్రహ్మసిద్ధాంత)—The second of the authentic *Sastras*.

BRAHMA'NDA', (బ్రహ్మాండ)—The mundane egg, created by *Brahma*—also the visible sky, which is supposed to be the shell of this egg.

BRA'HMYA, (బ్రాహ్మ్య)—(written *Brahman* in the Text)—The *Yoga* Star of the 25th Lunar mansion, *α Pegasi*. Vide p. 74.

BRISYA, (బ్రిజయు, విషు)—called *Vishu* in the Carnatic —The 15th year of the cycle of Jupiter. Vide I Chr. Table.

BRITASTA'N, (బృతస్థాన్)—Mentioned in the *Brahmánd'a Purana*, as the place of religious duty, is supposed by some, to be the Island of Great Britain. It is also called *Swéta dwip*, or the White Island—*Suvarná dwip*, or the Golden Island, is conjectured to be Ireland. The British Islands are (it is pretended) sometimes called *Chandra dwip*; and likewise *Trícalas'a*, or the Island with three Peaks, viz. *Rajátacútá*, *Ayacúta'*, and *Suvarná cúta'*.

BUDHA, (బుధ)—One of the names of Mercury—also a godhead, the founder of a religious sect, which is followed in different parts of India, and in all China. The epoch of the institution of *Budha's* religion is referred to the year 540 before Christ. According to Hindu Mythologers, he was the son of *Sóma* (the Moon) and the head of a dynasty, called on that account, *the Lunar line of Princes*. He flourished in tho beginning of the *Treta yug*. Modern commentators place his birth in the year 1424 before Christ.—*Budhu-vara*; Wednesday. Vide p. 6.

C

CACSHA, (కక్ష)—The orbit of a Planet, or the circle which ancient Astronomers called the *Deferent*; for the *Cacsha* carries Epicycles, (*Paridhis*) like the Deferent. This term is alluded to at p. 84 and 85 of the Text, and 247, IId Appendix.

CAL'A', (కళా)—An arc of one minute of a degree: also the Phases of the Moon, of which the Hindus count 16.—Mahà Calá; the conjunction or opposition of the Sun and Moon; vide p. 77.—Lagna Calá. Vide p. 102.

CA'LA'NILAM, (కాలానిలం)—One of the elements of the Vàcyam (spelt Vakiam in the Text) process; and containing 3031 days.

CA'LAYUCTI, (కాలయుక్తి)—The 52d year of the cycle of Jupiter. See I Chr. Table.

CALI, or CALCI, (కలి, కల్కి)—The 10th Incarnation of *Vishnu* in the shape of a *Horse* with a human head; vide p. 311.—Its anniversary noticed in the Kalendar.

CALI-YUG, (కలియుగ)—The fourth of the periods contained in a Maháyug. The iron age—consisting of 432000 Solar Sydereal years. Its epoch, i. e. that of its beginning, ascends to 3102 years before the Christian Æra. Vide Crita yug, also p. 7, 8, 77, 222, 228, 293, 302, Table LI, p. 68, and I and II Chr. Tables.

CALPA, (కల్ప)—literally Form.—The grand period of general conjunction. It consists of 4320000000 Solar Sydereal years; being the sum of 14 Manwantaras, with a *Sandhi*, or twilight of 1728000 Solar years; vide *Manwantara*; also p. 77.—*Calpa dina*, the day on which the *Calpa* began, or its anniversary, which is noticed in the Kalendar. Vide p. 319.

CANYA, (కన్య)—The Hindu Solar Sign *Virgo* ♍. Vide p. 5, and Table III.

CARCA'TACA', (కర్కాటక)—(spelt in the Text *Carcata*)—The Solar Sign *Cancer* ♋. Vide same pages as above.

CARANA, (కరణ)—(spelt in the Text *Curna*)—An astrological element importing the time during which the Moon's motion from the Sun amounts to 6°: there being 2 *Caranas* in one *Tithi*.—The Moon's synodical revolution is divided into 11 *Caranas*, 7 of which are ordinary and moveable, called *Chara;* and 4 extraordinary and fixed, called *Sthirra*—the time when the successive *Caranas* end, is inserted in the Ephemerides. Vide p. 73, 75, 79, 307.

CARNA, (కర్ణ)—The hypothenuse of a right angled Triangle—*Chala carna* (spelt *Chila carna* in the Text) the *true* distance of a Planet from the Earth, in contradistinction of its *mean* distance, represented by the Radius of the Deferent. When this term is so understood, the *Sudh'a coti*, and *Bhujajya*, form the other two sides of a right angled Triangle; vide *Bhú carna*, also p. 96, 98.—*Curna márgám;* a straight, or perpendicular line: also a ray of the Sun.

CA'RTICAY, or CARTIGA, (కార్తిక)—The 7th Hindu Solar month, when the Sun is in the Sign *Tula* ♎; answering to the Tamil *Arpesi*.—In the Southern parts of the Peninsula the Tamil month which is called *Cartiga*, is the 8th of the Solar year: care must therefore be taken not to confound these two *Cárticays*. In the Text the Southern name is invariably given to the 8th Tamil Solar month.—Lastly, *Cárticay* is also the 8th Lunar month of the Luni-solar year. Vide p. 5, 69, and Table III.

CA'SI, (కాశి)—Benares, a city which according to Hindu Geography lies in 27° 35′ of Latitude N. and 4° 37′ E. of *Lanca*. Vide Table XXXIII.

CASTA'CALA', (కాష్ఠకాలా)—A division of time equal to the 1-3600th part of a *Vicala*. Vide p. 5, 77.

CAULAVA, (కౌలవ)—The 3d ordinary *Carana*. Vide p. 75.

CHACRA, (చక్ర)—A Wheel; a Circle; a Cycle of years; a weapon of a circular form often placed in the hands of the gods.—*Rási chacra*, the Zodiac.—*Varahaspati chacra*, the cycle of 60 years.—*Nacshatra chacra*, the sphere of the fixed Stars.—*Prac chacra*, an epicycle on which the degrees of precessional variation are counted. Vide p. 5, 84, 85, 147, 230, 275.

CHADAM, (చదం)—An element of Spherical Trigonometry used for finding the Sun's altitude at a given instant. Vide p. 99.

CHATUSHPA'DA, or CHADESPADA, (చతుష్పద)—The 9th *Carana*, being the 2d extraordinary. Vide p. 75.

CHANDRA, (చంద్ర)—The most common name of the Moon.—☽'s *Madhyama Graha*, vide p. 83; Do. *Sphuta Do.* 83; ☽'s *Madhyama Gati*, 89, 131; Do. *Sphuta Do.* 89; for ☽'s *P'hala*, 123, and Tab. XXIII, XXV, XXVI; ☽'s *Mana*, vide p. 5, 57, 211, and II Chr. Table.—*Chandra panchanga*, the Luni-solar Kalendar. Vide p. 307, 318 to 322.

CHA'RA CANDA, or CUMDA, (ఛారఖండ or ఛరఖండం)—(the first C to be pronounced as in *charity*)—Ascensional difference.—N. B. When the words *Prathama*, *Madhya*, and *Antera* are prefixed to this term, it means the ascensional difference for I, II or III Signs of the Tropical Ecliptic; vide p. 103.—*Charadala*; an element required for computing the two *Vishuvas*, and the *Pushti*; vide p. 84.—*Charajya*, the Sine of the ascensional difference; vide p. 99.—*C'hara*, the 25th year of *Jupiter's* cycle. Vide I Chr. Table.

CHARA, (చర)—The 7th and ordinary *Caranas* when named collectively, (spelt *Charra* in the Text). Vide p. 75.

CHA'RUM, (చారం)—Vide *Pádachárum*.

CHALA CARNA, (చలకర్ణ)—(Written *Chila carna* in the Text)—Vide *Carna*.—This term means the true distance of a Planet from the Earth, in contradistinction to its mean distance, or the Radius of the *Cacsha*, or Deferent. Vide p. 186, 189, and the Tables from XLI to XLV.

CHATURDASI, (చతుర్దశి)—The 14th day of the Lunar Pacsha. Vide p. 70.

CHATURTHA P'HALA, (చతుర్థఫల)—The second inequality or equation of a Planet, answering to the annual Parallax of a superior Planet and the elongation of an inferior one.

CH'HA'YA', (ఛాయా)—(written *Chya* in the Text, and spelt in a variety of ways in European books which treat of Hindu astronomy; sometimes *Chóya*)—Shadow.—Under this term we have a variety of elements which are multiplied by mistake in consequence of Europeans varying their manner of writing oriental words.—*Vishuva ch'ha'ya'*, the Shadow of a Gnomon, when the Sun is in the Equinoctial points.—*Madhyama ch'ha'ya'*, the midday Shadow of the same at any other time of the year.—*Sama mandala ch'ha'ya'*, the midday Shadow of the same when the Sun is East or West of the Gnomon ; vide p. 84, 91, 94, 186, 189.—*Ch'haya suta* ; one of the names of Saturn, meaning *Born from Darkness.*

CHITRA, CHAITRA, AND CHAITRAM, (చిత్ర, చైత్ర)—The 1st month of the Tamil Solar year, (always spelt *Chaitram* by F. Beschi, and in the Text) answering to the Hindu *Vaisac'ha,* when the Sun is in the Sign Mesha ♈.—But this name is that of the *last* month of the Hindu Solar year used every where (excepting in the land of Tamil,) when the Sun is in the Sign Min ♓, answering to the Tamil Pungoni : a circumstance which must be carefully attended to ; vide p. 5, and Table III. –Lastly, *Chaitra* is the name of the 1st month of the *Luni-solar year* which begins on the new Moon preceding the Sun's entrance in the Sign Mesha ♈ ; vide p. 69.—N. B. This variety of significations of the same term or rather of terms so nearly resembling each other, requires the greatest attention, when adverting to dates, and reading books written in different countries.

CHITRAB'HANU, చిత్రభాను)—The 16th year of the cycle of *Jupiter.* Vide I Chr. Table.

CHOUTI, (చౌతి)—The 4th day of the Lunar *Pacsha* or demi-lunar month. Vido p. 70.

CI'LACA, (కీలక)—(the C to be pronounced hard)—The 42d year of the cycle of *Jupiter.* Vido I Chr. Table.

CIMASTUGHNA, OR RHIMUSTOGUNA, (కింస్తుఘ్నం)—(the C to be pronounced hard)—The 11th and extraordinary *Carana.* Vide p. 75, 318.

COT'I, (కోటి)—The complement of an arc to 90° : also one of the sides of a right angled triangle.—*Sudda coti ;* the sine.—*Cotijya,* the cosine of an angle in such a triangle.

CRADI OR CRODHI, (క్రోధి)—The 38th year of *Jupiter's* cycle. Vide Chr. Table I.

CRAMAJYA, (క్రమజ్య)—The sine of a Planot's declination.—*Paramapáma-cramajya,* the sine of its greatest declination, (written *Paramapa* in the Text). Vide p. 92.

CRA'NTAM, (క్రాంతం)—(in the Text *Crantum).*—An astrological element, explained at p. 308. Vide also p. 76 and Kalendar.

CRA'NTI, (క్రాంతి)—literally, *Ascending, surmounting* ;—astronomically, *declination* ; vide p. 5, 84.—*Cránti bhagas,* the declination of a point of the Ecliptic ; vide p. 91, 97.—*Cránti cacsha,* or *mandala,* the Ecliptic ; vide p. 91.—*Cránti jya,* the sine of the declination ; vide p. 105.—*Cránti pata,* literally the Nodes of the Ecliptic, or the Equinoctial points.—*Cránti Pata-Gati,* literally the motion of the Nodes of the Ecliptic, but more precisely what Europeans call precessional variation. Vide p. 86, 247, and refers to the whole of Appendix II.

CRISHNA, (కృష్ణ)—One of the *Avatáras,* or descents of *Vishnù* ; supposed to have lived at the time when *Yudhisht'hira* flourished, but whose epoch, according to Mr. Bentley, descends to A. D. 600 As *Vishnù* is a personification of time, so is his identical incarnate being.—As a hero, *Crishna's* feats are recorded in the *Máhábhárata,* a celebrated poem describing a fictitious war—The anniversary of this incarnation is noticed in the Kalendar. Vide p. 311.

CRISHNA PACSHA, (కృష్ణపక్ష)—The latter, or dark half of the Lunar month ; also called *Bahula pacsha.* Vide p. 68, 314, 320.

CRITA YUG, (కృతయుగ) Vide *Satya yug.*

CRITICA, (కృత్తిక)—The 3d Lunar mansion. Vide p. 74.

CRO'DHANA, (క్రోధన)—The 59th year of *Jupiter's cycle.* Vide Chr. Table I.

CSHAIA, (క్షయ)—To *wane*, to *waste*, to *decline.*

CSHAYA, (క్షయ)—Derived from *Cshai.*—*Cshaya tithi*, an expunged Lunar day.—*Cshaya masa.* Do. Lunar month.—*Cshaya samvatsara*, a Luni-solar year with two intercalary and one expunged months.—*Cshaya Varahaspati mana*, a year expunged out of *Jupiter's* cycle of 60 years. Vide p. 64, 68, 71, 72, 78, 79, 137, 142, 206, 209, 301, and IId Chr. Table.

CSHE'PA, (క్షేప)—*A constant number to be added in certain computations to fit a particular epoch; in contradistinction of Sódhya* which is to be subtracted. Vide Pr. p. xi, Text p. 54, 203, 239.

CSHE'SHNA, (క్షేషణ)—The part of the Moon's disc obscured in an Eclipse. Vide p. 343.

CSHE'TRA GANITA, (క్షేత్రగణిత)—Geometry.—*Cshetra Dersa.* A treatise of.

CSHITI'JA, (CACSHA),—(క్షితిజ, కక్ష)—The horizon.—*Cshitijya*, the sine of an arc referred to the horizon, used for finding the ascensional difference. Vide p. 91, 98, 105.

CSHYA, (క్షయ)—The 60th year of *Jupiter's* cycle. Vide Chr. Table I.

CUJA, (కుజ)—One of the names of the Planet *Mars.*

CUMB'HA, (కుంభ)—The Hindu Solar Sign *Aquarius* ♒. Vide p. 5 and Table III.

CUME'RU, (కుమేరు)—The Southern hemisphere, or Pole—a fabulous region where *Yama* presides over the *A'surás* and *Daityas.* (Vide *Sumeru*).

CU'RMA, (కూర్మ)—The 2d Incarnation of *Vishnù* in the shape of a *Tortoise.* Vide p. 311.

D

DACSHA SAVARNI, (దక్షసావర్ణి)—One of the 14 Patriarchs who preside successively over the 14 *Manwantaras* of the *Calpa.* Vide p. 311.

DACSHIN'A, (దక్షిణ)—*The South point of the compass.*

DAITYA'S, (దైత్య)—Vide *Asurás.*

DANDA, (GHATICA),—(దండ)—The 1-60th part of a day, so called in the mode of dividing time called *Murta.* Vide p. 5, 77.

DARSA'NA, (దర్శన)—Intuition.—*Ananta darsana*, infinite knowledge.

DES'A, (దేశ)—A country or region.—*Niracsha dés'a*, the Equatorial parts of the Earth.

DESAMI, (దశమి)—The 10th Lunar day of the *Pacsha.* Vide p. 70.

DESANTARA, (దేశాంతర)—The distance of any two meridians or the surface of the Earth; or what Europeans call *Longitude.*—Also the difference of Longitude, or allowance made for a Planet's proper motion, between the time of its being upon the first meridian, and its coming to that of a given place. But this is not to be understood in the same sense as what Europeans call the Longitude of a Planet. Vide *Sayana*, also p. 95, 107, 109, 130, 131, 134, 135, 338, and Tables **XXXIII, XXXIV** and **XLVII.**

DE'VARAM, (దేవరం)—An element of the *Vacyam* process containing 248 natural days. Vide p. 121, 132, 133, 335, and Table XXVI.

DE'VATA'S, (దేవతాః)—Benign spirits governed by *Indra*, properly the inhabitants of the North Pole; for the *Dévatás* are said to have day, when the *Daityás* have the night, and vice versa. Vide *Surás.*

DE'VI, (దేవి)—A term used in the Kalendar to signify *day time*. Thus *Tyájyá* Devi (wrongly spelt *Thyajum* in the Text) means that the Tyájyá occurred at day time. Vide p. 75, and Appendix IV.

DHANA, (ధన)—The sign of affirmation, or addition, of the same import with + or plus.

DHANISH'TA, (ధనిష్ఠ)—The 23d Lunar mansion. Vide p. 74.

DHANUH, DHANUS, or CHA'PA'M, (ధనుః, ధనుస్)—An arc of a circle.

DHANUR MARGAM, (ధనుర్మార్గం)—A curve line.

DHANUS, (ధనుస్)—The Solar Sign *Sagittarius* ♐. Vide p. 5, and Table III.

DHA'TA, (ధాతు)—(Vide *Ghati'ca-dandas*, and p. 5.)—Dháta, the 10th year of the cycle of Jupiter. Vide Chr. Table I.

DHANWANTARI, (ధన్వంతరి)—The celestial Physician, who was produced by the churning of the ocean.—Time.

DHRĬTI, (ధృతి)—The *Yoga* Star of the 8th Lunar mansion, δ *Cancri.* Vide p. 74.

DHRUVA, (ధ్రువ)—Generally the Pole of a great circle of the Sphere—Particularly the Celestial Poles.—*Uttara Dhruva*, the North Pole; also the *Polar Star.*—*Dacshin'a Dhruva*, the South Pole.—This term is also used to signify a constant arc, referring to the distance of a Planet from the beginning of the Sydereal Zodiac.—*Dhruva* means more commonly an epoch to which a computation is referred. Lastly, it is the name of the *Yoga* Star of the 12th *Nacshatra*, supposed to be the same as β *Leonis.* Vide p. 74, 85, 123, 133, 144, 152, 182, 230.

DIC, (దిక్)—(wrongly spelt in the Text *Dikus*)—The four cardinal points of the compass.—*Astá dic;* the 8 principal points including the cardinal ones; and wrongly stated in the Text at p. 92, to mean only the 4 intermediate points.—The *Astá dic* are called the eight corners of the world, over each of which a divinity is supposed to preside. Vide p. 92.

DINA, (దిన)—A day, considered in a great variety of ways and durations, of which the following are the principal.: 1º A *Sávana*, or *Bhúmi sávana* dina. A natural day, being the time between two Sun risings. 2º A *Saura dina;* of these there are two kinds; and the similarity of the name tends to confuse much the beginners in the study of Hindu Astronomy. First; the absolute sense of *Saura*, being *Sydereal*, the *Saura dina* is the time between the same point of the Ecliptic rising twice; or, more precisely, the time between the Equinoctial points rising twice. Second, the other *Saura dina*, is the time which the Sun takes to describe one degree of the

Ecliptic. It follows therefore, that strictly speaking, neither of these kind of days are equal throughout the year; yet the former, (which is also called *Núcshatra dina*) are supposed to be so in the first steps of several operations. Such is also the case with the latter, but this only happens when calculating the mean elements of the Planets by the *Vacyam* process. 3º *Diva dina*, is equal to a Sydereal revolution of the Sun. 4º *Pitrya dina*, to a Synodical revolution of the Moon. 5º *Brahma dina*, is equal to a Calpa, or 4320000000 years, his nights being equal to his day.—*Yuga dina*, is another word for *Ahargana*, meaning the number of days expired from the commencement of a *Yug*.—Lastly, *Yuga dina* means the anniversary day of that on which a *Yug* began, which is always noticed in the Kalendar.—N. B. This term is to be found in every part of the work, and therefore needs not be particularly referred to. Vide, however, p. 5 and 77.

DIN.A'RDHA, (దినార్ధ)—Half the time of the Sun being above the horizon. Vide p. 92, 106, 318.

DUADESI, or DWADESI, (ద్వాదశి)—The 12th day of the *Pacsha*, or demi-lunar month. Vide p. 70.

DUNDUBHI, (దుందుభి)—The 56th year of Jupiter's cycle. Vide Chr. Table I.

DURGA, (దుర్గ)—A personification of the Solar year.

DWA'PARAYUG, (ద్వాపరయుగ)—(wrongly spelt in the Text *Devapar yug*).—The third of the periods contained in a *Mahá yug*. Its duration is of 864000 Saura years. The *brasen age* of the Hindus. Vide p. 7, 77.

DWIJYA', (ద్విజ్య)—The Sine; but more properly the Chord of an Arc; vide Jiva.—Also the Sine of the Sun's declination when his Longitude is II Signs. Vide p. 101.

DWIJYA' MA'RGAM, (ద్విజ్యామార్గం)—An horizontal line.

DWIJYA' PINDA', (ద్విజ్యాపిండ)—The Sine of 3° 45'; vide *Pinda*, also the whole of Article 8 of Part I of the Key to the *Siddhanta Chandra mana*; and Table XXX, p. 39 of the Tables.

DWI'PA, (ద్వీప)—An extensive region or continent.

G

GANDA', (గండ)—The *Yoga* Star of the 10th Lunar mansion, *Regulus*. Vide p. 74.

GA'NE'SA', (గణేశ)—One of the names of the god of wisdom.

GANITA S'A'STRA, (గణితశాస్త్ర)—Astronomy. A treatise of.

GARGA, (గర్గ)—An ancient Astronomer; the Guru, or instructor of *Yudhisht'hira*, one of the Princes of the *Lunar* line.—That *Garga* was cotemporary with *Yudhisht'hira* is contested by some modern commentators, who assign the year 548 before Christ for the time when he flourished.

* GARUD'A, (గరుడ)—The Bird of Vishnù. An epithet of the Sun: but not admitted by the Madras Pundits.

GATI, (గతి)—Generally, motion.—Specially, the diurnal motion of a Planet in its orbit; vide p. 88, 89, 107, also Tables XX, XXI for the Sun and Moon, and the first part of Tables XLI, XLII, XLIII, XLIV, XLV for the daily motion of *Mars*, *Mercury*, *Jupiter*, *Venus*, and *Saturn.*—*Madhya Gati ;* mean motion.—*Sphuta Gati ;* true or apparent motion.

GAUN'A CHA'NDRA MA'SA, (గౌణచాంద్రమాసు)—The Lunar month when it begins at the full Moon, called secondary.

GHATI'CA, (ఘటిక)—An Indian hour, 24 minutes European time, (vide Danda).

GRAHA, (గ్రహం)—The Planets.—A moveable point in the heavens. The Planets have each a great number of names, or epithets; many of which are to this day unknown to Europeans. The following, however, are known to every Indian, because they serve to give a name to the seven days of the week: 1º *Ravi*, or *Surya;* the Sun. 2º *Chándra*, or *Soma ;* the Moon. 3º *Mangala*, or *Cuja;* Mars. 4º *Budha ;* Mercury. 5º *Guru*, or *Vrïhaspati ;* Jupiter. 6º *Sucra*, or *Bhrïgu ;* Venus. 7º *Sáni*, Saturn. Vide p. 6.—Besides these, the Hindu Astronomers consider *Ráhu*, the Moon's ascending, and *Cétu* her descending Nodes, as obscure Planets, which occasion the Eclipses of the Sun and Moon. Vide p. 308.—The Tables from XLI to XLV give the mean motion, Anomalistic equation and Annual equation of the five Planets known to the Hindus.—*Graha*, when the terms *Madhya* and *Sphuta* are prefixed to it, signifies the mean, and apparent place of the Planet in the Hindu Sydereal, or fixed Zodiac. Vide p. 83, 87, 280.—*Graha lághava*; a treatise on Astronomy, written about the 4657th year of the Cali yug (A. D. 1555.)

GRAHANA', (గ్రహణ)—General term for an Eclipse; vide p. 343.—(*Grahana tinooria padhi*, a term used by common Kalendar makers for half the duration of an Eclipse, but the word *Tinooria* is not *recognized* by the regular Sastries). Vide p. 345.

GRAHA PARIVRITHI, (గ్రహపరివృత్తి)—An account of time used by the inhabitants of the Southern Provinces of the Peninsula of India. It consists of a cycle of 90 Solar Sydereal years of 365^d 15^g 31^v 30^p Indian, or 365^d 6^h $12'$ $36''$ European time. Vide p. 51, 295, 302, 303, and Table II, p. 2 of the Tables.

GRI'SHMA, (గ్రీష్మ)—The 2d Season of the year, comprehending the months *Jyest'ha*, and *A'shád'ha*, when the Sun is in the Signs Vrisha ♉, and Midhuna ♊; answering to the Tamil months Viassei and Auni. (*)

GUDIYA, GHATI'CA, (ఘడియ, ఘటికా)—(spelt in all this work *Guddia*)—*Ghatica*, the Sanscrit, and *Gudiya*, the Telugu, names of a space of time equal to 1-60th part of the natural day, or 24 minutes of European time: the same as a *danda*. It is divided sexagesimally into *vigudiyas*, *paras*, *suras*, &c. The *Gudiya* referring to time, must be distinguished from an arc of the same name, which divides a Lunar mansion, or *Nacshatra*, (13° 20′) into 60 parts, subdivided likewise sexagesimally as the measure of time into *vigudiya*, &c. Vide p. 6, 77.

(*) It has been observed at page 4 in the note (+) that the Tamils reckon their Seasons to begin one month later than the rest of the Hindus; so that in the present case the Tamil Season of Grishma would comprehend the months of *Auni* and *Audi*. In order not to perplex the reader's attention by multiplied explanations, the present observation will not be repeated in the other articles which refer to the Seasons.

GURU, (గురు)—One of the names of Jupiter; also a spiritual guide, preceptor, teacher, &c.—*Guru vara*, Thursday. Vide p. 6, and Table XLIII.

H.

HA'RAM, (హారం)—The denominator of a fraction.

HARSHANA, (హర్షణ)—The *Yoga* Star of the 14th Lunar mansion, *Spica Virginis*. Vide p. 19, 74.

HASTA, (హస్త)—The 13th Lunar mansion. Vide p. 74.

HEMALAMVA, or **HE'VILAMBI**, (హేవిళంబి)—The 31st year of the cycle of *Jupiter*. Vide Chr. Table I.

HE'MANTA, (హేమంత)—The 5th Season of the year, comprehending the months of Margasiras and Paushya, when the Sun is in the Signs Vrischica ♏ and Dhanus ♐, answering to the Tamil months Cartiga and Margali.

HO'RA, (హోర)—The 1-24th part of the natural day, answering to an European hour. A measure of time probably introduced in India by the Europeans.

I

ICSHWA'CU, (ఇక్ష్వాకు)—The first king in the *Solar* line, who reigned at the commencement of the *Treta yug*. He was the son of the 7th *Menu*, or Patriarch, the offspring of the *Sun*. His posterity was called in consequence, the dynasty of the *Solar Princes*, in the same manner as *Budha* was reputed the head of the *Lunar* line. Modern commentators bring the time of his accession down to the year 1320 before Christ. Vide p. 311.

INDRA (MAHA'), (ఇంద్ర)—The god of thunder; a personification of the sky.—The chief of the *Dévatas*, or *Súras* (vide *Dévatas*);—also, the *Yoga* Star of the 26th *Nacshatra*, γ *Pegasi*. Vide p. 74.

INDU, (ఇందు)—A name of the Moon. That name is commonly given to her when that of *Arca* is applied to the Sun; or in a compound form. (Vide *Arc'endu Sangama*).

IS'WARA, (ఈశ్వర)—The 11th year of the cycle of *Jupiter*. Vide Chr. Table I.—Also, an epithet of *Siva*. (Vide *Siva*).

ITIEK, (ఇత్యేక)—Two syllables added by certain Southern Astronomers, to the name of a Lunar month when it is an intercalary one. Thus *Phalguna-Itiek* indicates that the said Lunar month is to be repeated. This term is a compound of *Iti*, this is; *ek*, one; signifying that the month so named is that which *is truly intercalated*, the month Phalguna which precedes it, being the *Nija* or proper one. In the Carnatic, however, the same month would be called *Athica Chitra*, and the following *Nijah Chitra*, the first being that which is intercalated; so that according to either denomination the intercalated month is the same.

JAISH'THA, (జ్యేష్ఠ)—The second month of the Hindu Solar year, when the Sun is in the Sign *Vrisha* ♉, answering to the Tamil month *Viassei*. Vide p. 5, and Table III.

JAMBU DWI'PA, (జంబుద్వీప)—One of the seven grand divisions of the Earth, including Asia ; so named from the tree called *Jambú* abounding in it.—Modern commentators, however, pretend that it refers only to certain parts of the interior of Asia.—The *Eden* of the Hindus.

JAMNA PATRICA', (జన్మపత్రికా)—What Astrologers call the *Nativity*.—The aspect of the Planets in the heavens, at any proposed instant of time.

* JANU, (జాను)—Literally means the Knee. It is therefore difficult to understand why in some places it is used as an epithet of the Sun.

* JANU SEPTAMI, (జానుసప్తమి)—In some books is a term used to indicate the beginning of the year ; but it is unknown as such to the Pundits of the Carnatic.

* JARA'SAND'HA; (జరాసంధ)—The name of a celebrated king who reigned in *Maghada*, the head of a dynasty which followed that of the Solar and Lunar lines.

JI'VA, (జీవ)—(sometimes written *Jya* or *Jaya* in European books on Hindu Astronomy.)—The Chord of an Arc ; but frequently written for *Ardha-jya*, " half the String of the Bow", which comes to the same as our definition of " half the Chord of double the Arc." Vide p. 92, and Table XXX, with demonstrations from p. 39 to 42 of the Tables.

JYA' PINDA'S, (జ్యాపిండ)—The Sines of the 24 *Pindas* (3° 45′ each) into which the Quadrant is divided. Vide as above.

JYA'TACA, (జాతక)—Astrology.—A Horoscope.—*Jyátaca Sástra.* A treatise on.

JYEST'HA, (జ్యేష్ఠ)—The 18th Lunar mansion. Vide p. 74.

JYO'TISH SA'STRA, (జ్యోతిశ్శాస్త్ర)—Any treatise on Astronomy.—*Jyótish Sástri*, a title assumed by the Indian Astronomers, (always wrongly spelt in the Text *Jyautish* Sastras). Vide Pr. p. iii, and Text p. 281.

JYO'TISHTAVA, (జ్యోతిష్టవ)—A treatise on Astrology. Vide p. 197, 202, and Tables XIV and XIX.

K

KA'LA, or CA'LA, (కాల)—(always written *Kala* in the Text).—Time in its natural acceptation. This term, as it sounds to the ear, is applied to a great variety of mathematical and astronomical subjects, several of which may be collected out of the expositions contained in this Glossary.

KATAPAYA'DI, (కటపయాది)—Special Arithmetic ; of the same import as Algebra.

* KAUSTUBHA, (కౌస్తుభ)—An epithet of *Vishnú*. A sparkling gem, worn by that deity ; elicited by the churning of the ocean : it is in some places taken as an emblem of the Sun ; but the Pundits of the Carnatic do not admit of that allegory.

KE'NDRA, (కేంద్ర)—and (according to Sir Wm. Jones' orthography) *Céndra*.—Answers to what Europeans call the argument of an equation.—*Patana céndra*, the argument of the latitude.—*Dwitiya céndra*, the supplement to a whole circle of what Europeans call mean anomaly ; being the distance of the higher Apsis, from a Planet in any point of its orbit.—*Síghra céndra*, the commutation ;

being the distance of the Sun from a superior Planet; or the distance of an inferior Planet from the Sun.—*Manda céndra*, the argument of anomaly. Vide p. 87, 88 and other places.

KE'TU, or *CE'TU*, (కేతు)—The Moon's descending Node. Vide *Graha*, also p. 77, 308, 310.

KRITA, or CRITA YUG, (కృతయుగ)—The same as *Satya yug*; the golden age of the Hindus; which consists of 1728000 Solar Sydereal years; being the first of the four periods contained in a *Maha yug*. Vide p. 7, 77.—N. B. Some Astronomers and Commentators, reverse the numerical order of these *yugs*, and would therefore call this the fourth.

L

* LAC'SHMI', (లక్ష్మి)—The name of the goddess of *wealth*.—This word applies to a multitude of objects; too numerous to be repeated. In some parts of Northern India *Lacshmi* is a personification of the Luni-solar year; in the same manner as *Durga* is that of the Solar one: but this allegory is rejected by the Pundits of the Carnatic, who likewise deny what some pretend, that she lends occasionally her name to the Moon, and even to Jupiter.

LAGNA, (లగ్న)—The Arc of the Equator which passes the Meridian in the same time with each Sign of the Ecliptic; and as *Lanca* is supposed to lie under the Equator, its *Lagna*, is called *Madhya lagna*. —*Lagna bhuja*, means the Ascensional difference. Vide p. 92, 101, 102, 104, and Table XXXII.

LAMBA, (లంబ)—The Co-latitude, or the Arc between the Pole and Zenith of a given place.—*Lambajya*; its Sine, or the Cosine of the Latitude. Vide p. 94.

LANCA', (లంకా)—One of the four imaginary cities which are supposed to lie under the Equator at 90° distance from each other; viz. 1o *Yavacót'i*; 2o *Lanca*; 3o *Romaca*; and 4o *Siddhapuri*. At page 9 of the Text, *Bornacoti* was stated to be the 3d; but the Pandits have rejected that spelling.—*Lanca* is considered by all manner of Indian Astronomers, to lie under the first Meridian: to which all computations should be referred; *though several (and particularly the Telugus)* refer to that of *Raméswara*. Towards the North, and under the same Meridian as *Lanca*, the Sastra states that there are two other cities and a great mountain, viz. *Avanti* (supposed to be the same as *Ujani*, or *Oogein*), Rohitaca, the mountain, and *Sannihita sarah*, which in former, or rather fabulous times, were the seats of Colleges and Observatories. The Meridian of *Lanca* lies in 75° 53′ 15″ (5^{h} 3′ 33″) East of Greenwich; and 73° 33′ (4^{h} 54′ 12″) East of Paris. Vide p. 9. N. B. all the operations contained in this work which always refer to that Meridian.

LATTA, (లత్తా)—An element of astrology. Vide p. 76, 309, and Appendix IV.

* LIBITA, (లిప్తా)—(Mandala Yogarda),—The side of a Spherical Triangle, with the argument of the Latitude of a Planet, and its Latitude for the other two.—N. B. The Tamil Astronomers resolve this Triangle as one of plane Trigonometry, and use it for finding the *Csh'shna*, or quantity of the digits obscured in an Eclipse.—*Libitangula*; digits referred to the same. Vide p. 312, 313.

LI'LA'VATI' GAN'ITA, (లీలావతీగణిత)—A general term for the science of the mathematics, of which it is said that the best known treatises are those of *A'rya bhatta*, and *Bháscara;* which may be correct for this part of India, where few original books on the sciences are to be found.

LIPTA AND VILIPTA, (లిప్త, విలిప్త)—Measure of time (vide *Vicala*) equal to one minute and one second.

LO'CAS, (లోక)—Fourteen Spheres, imagined to be allotted for the residence of different species of animated beings. The seven superior Lócas are, 1º The *Bhu-lóca*, or surface of the Earth. 2º *Bhuva.* 3º *Sivargu.* 4º *Maha.* 5º *Jana.* 6º *Tapa;* and 7º *Satya lócas.*—The inferior Lócas are, 1º *Atala.* 2º *Vitala.* 3º *Sutala.* 4º *Talátala.* 5º *Mahatala.* 6º *Rasatala;* and 7º *Patála lócas.*

M

MACARA, (మకర)—The Hindu Solar Sign *Capricornus* ♑. Vide p. 5, and Table III.

MADHYA, OR **MADHYAMA**, (మధ్య, మధ్యమ)—Signifies mean, in contradistinction to *Sphuta*, for true or apparent.—*Madhyama graha*, or *gati*, mean place or motion of a Planet; vide p. 1, 83, 86.—*Madhya ch'háyá*, the midday shadow of the Gnomon on any day of the year, excepting those of the Equinoxes. Vide p. 97.

MA'GH, OR **MA'GHA'**, (మాఘ)—*Magh*, the 10th Hindu Solar month, when the Sun is in the Sign *Macara* ♑, answering to the Tamil month *Tye;* vide p. 5 and Table III.—*Maghà*, the 10th Lunar mansion. Vide p. 74.

MAHA', OR **MAHE'**, (మహా)—Great.—*Maha yug*, a great period of conjunction or opposition.—*Mahé Indra;* the great *Indra*, &c.

MAHA'BHA'RATA, (మహాభారత)—An historical poem of great celebrity; in the first book of which is given an account of the war between the *S'uras*, and *As'uras*, in which the gods intervened. This poem is interesting to Astronomy, because it records the first Eclipse of the Sun mentioned in any of the *Sastras*. Modern European commentators suppose that it was written in the year 786 of the Christian Æra, and that the date of the Eclipse which it records is the 25th October in the year 945 before Christ, and therefore anterior to that transmitted to us from the *Chaldeans*, which was observed on the 19th March A. A. Christum 720.

MAHA YUG, (మహాయుగ)—A grand period of general conjunction, containing 4320000 Solar Sydereal years, and comprehending the four lesser *yugs*. Vide *Cali*, *Dwapara*, *Treta* and *Satya yugs;* also p. 7, 77.

MALAYALA, (మలయాళ)—The name given to the lands which extend from *Mangalore* to Cape *Comorin*, following the Coast of *Malabar*. Vide p. 130, 298; of Chr. Tables, p. vi and Table I.

MALLI CA'RJANADU, (మల్లికార్జునుడు)—(wrongly spelt in the Text *Mulla Carjanada*)—A Telugu

Astronomer, who is supposed to have flourished in the 4279th year of the Cali yug (1100 Saca) who like *Bálá dityaca* referred his computations to the Meridian of *Ramiswara.* Vide p. 9.

MA'NA, (మాన)—Generally a *Measure.*—In Astronomy a mode of reckoning the duration of the year, whether as *Saura, Chandra, Savana, Nácshatra, Varahaspatiya, Brahmya, Dayoya, Pitriya,* or *Prájapatiya.*—The principal mode of reckoning the year as now practised by the Hindus is, either Solar, or Luni-solar.—The Solar is the time which the Sun takes to perform a complete revolution round the heavens, beginning from a Star and returning to the same. The Solar Hindu year is therefore Sydereal; but it is taken to be of various durations, according to the systems and authorities which are followed.—The Luni-solar year in most general use, or the common *Chandra mana,* consists of 12 or 13 Lunar months. It commences with the *new* Moon at, or next before the time when the Sun enters the first Sign of the Solar Sydereal Ecliptic. Its months are called *Muc'hya* or primary.—The *Barhusputya* (wrongly spelt in the Text *Banu Husputtiah*) *Chándra mana,* is another sort of Luni-solar year, which begins at the wane of, or the full Moon next preceding the Sun's entrance into the Sydereal Ecliptic. Its months are called *Gauna,* or secondary; vide p. 1, 57, 63, 77, and of Chr. Tables p. ix and Tables I and II.—The *Vrihaspati mana,* or Jupiter's year, is properly the time during which the Planet describes one Sign of its orbit. However, in the Peninsula of India, it is taken to be equal to the Solar year, and in present times serves only to give a specific name in a cycle of 60 years, to each Solar and Luni-solar year. Vide Third Memoir, p. 197, and Chr. Table I; also Samvatsara.

MANDA, (మంద)—What Europeans call Anomaly.—*Manda p'hala,* the Anomalistic equation of any Planet. —A name of *Saturn;* vide p. 87, 89, for the Sun and Moon, Tables XXII, XXIV, and XXIII, XXV; for the Planets, IId part of Tables from XLI to XLV.

MAND'ALA, (మండల)—A Circumference, a great Circle.—*Nádi mand'ala* (spelt Nari in the Text)—The Equator.—*Cránti mand'ala,* the Ecliptic. Vide p. 5, 91, 342.

MANDOCHA, (మందోచ్చ(—The Apses of a Planet's orbit.—*Tunga mandocha,* the higher Apsis. Vide p. 11, 76, 83, 84, 154.

MANGAL'A, (మంగళ)—A name of the Planet *Mars.*—*Mangal'a vara;* Tuesday. Vide p. 6, and of the Tables the XLIst.

MANMAT'HA, (మన్మథ)—The 29th year of the cycle of Jupiter. Vide Chr. Table I.

MANUS, or MENU, (మను)—Fourteen Patriarchs who are supposed to preside successively over the same number of *Manwantaras* of which the *Calpa* is composed, and whose anniversaries are noticed in the Kalendar. Vide p. 311.

MANWANTARA, (మన్వంతర)—A period of 308448000 Solar Sydereal years; of which there are 14 in a Calpa, with a *Sandhya,* or twilight, equal to the *Satya yug.* Vide p. 77.

MA'RCANDA', (మార్కండ)—An Astronomer who has left several useful Tables, of a modern date. Vide Pr. p. ix, Text p. 87, Tables XXIV & XXV.

MARGALI, (మార్గళి)—The 9th *Tamil* Solar month, answering to the Hindu *Paushya*, when the Sun is in the Sign *Dhanus* ♐. Vide p. 5, and Table III.

MARGASIRAS, (మార్గశీర్షం)—The 8th Hindu Solar month, answering to the Tamil *Cartiga*; when the Sun is in the Sign *Vrischica* ♏.—This month is also sometimes called *Agrahayan*, a name which was given to it when it was made to begin the Solar year. Vide p. 5, 245, and Table III.

MA'SA, (మాస)—(wrongly spelt Masha in the Text)—A month, whether Solar or Lunar, and consequently of various durations.—The first month of the Solar year is called in the *Suryah Siddhanta*, *Mésha mása*, because the Sun is then in the Sign *Mésha* ♈, answering to the Hindu month *Vaisác'ha*, and Tamil *Chitra* (always spelt *Chaitram* in the Text).—It is also the first month of the common Luni-solar year, called *Chaitra* (whether it opens with the new or full Moon), and therefore, refers to two sorts of Luni-solar years.—The *Nacshatra Chandra masa* is the time which the Moon takes to move through a *Sydereal* revolution.—The common Lunar Kalendar month, Do. through a *Synodical* revolution.—*Deva masa*, 30 Sydereal years.—*Brahma masa*, 30 of his days. Vide *Mána;* also p. 5, 11, 53, 69, 77, and Table III.

MATSYA DE'VA, (మత్స్యదేవ)—One of the incarnations of *Vishnù* as a *Fish*. Vide p. 311.

MASI, (మాశి)—The 11th Tamil Solar month; answering to the Hindu *Phalguna*, when the Sun is in the Sign *Cumbh'a* ♒. Vide p. 5, and Table III.

ME'RU, (మేరు)—Seems to mean strictly the Terrestrial Orb; or yolk of the mundane egg.

ME'SHA, (మేష)—The first Sign of the Solar Sydereal Zodiac, the Hindu *Aries;* vide p. 5, & Table III.—*Mésha Ayaná;* the Vernal Equinoctial point (vide *Ayaná*).

MID'HUNA, (మిథున)—The 3d Sign of the Hindu Ecliptic ♊, the Hindu *Gemini*. Vide p. 5, and Table III.

MIHIRA, (మిహిర)—An epithet of the Sun.

MI'NA, (మీన)—The 12th Sign of the Ecliptic ♓, the Hindu *Pisces*. Vide p. 5, & Table III.

MRĬGASI'RAS, OR MRĬGASI'RSHA, (మృగశీర)—The 5th Lunar mansion. Vide p. 74.

MUC'HYA, (ముఖ్య)—A name given to the Lunar months of the *common Chándra mana*; meaning *primary*. Vide p. 148.

MU'LA, (మూల)—The 19th Lunar mansion. Vide p. 74.

MUNI, (ముని)—Supernatural Beings to whom Suryah (the Sun) revealed the science of Astronomy.

MU'RTA, (మూర్త)—literally, the twinkling of an eye,—figuratively, a mode of reckoning small portions of time.—The *Nacshatra* days (all of which are supposed to be equal throughout the year) contains 60 *dandas* ÷ 60 *vicálás* ÷ 6 *pránácálás* ÷ 10 *castácálás*, or respirations. The latter answering, therefore, to a second of Hindu time ÷ 60 *alipalas* ÷ 3600 *nimeshas*, &c.—N. B. The sexagesimal order is interrupted after the *vicálás*, which are only subdivided into 6 *pránácálás* for the purpose of procuring a numerical division of time equal to the number of minutes of a degree contained in the circumference of a Circle, being 21600. Vide p. 6, 92, 104.

N.

NACSHATRA, (నక్షత్ర)—Properly a Star: Hence the Sydereal year, month, or day, are called *Nacshatra samvatsara, masa*, or *dina*.—But that term means also a Constellation, and still more particularly, any one of the 27 mansions of the Moon; we shall especially consider the latter at article *Richa*. A Lunar mansion contains an arc of 13° 20′ of the circumference of the Zodiac (27×13° 20′=360), therefore a Solar Sign contains 2¼ Nacshatras ([illegible] = 2¼ Nacs.)—There are a *fixed* and a *moveable* Lunar, as well as Solar Zodiacs: therefore there are also *fixed* and *moveable* Signs, and *Nacshatras*, the motion of the latter being equal to the progress of the *Ayanansa* (54″ per annum, *Suryah Siddhanta*). This distinction occasions, the same ambiguity, when Indian authors speak of these Signs and *Nacshatras*, as there is with us when we say that "*Aries* has got into *Taurus*". But they present this juxta position of the fixed and moveable Signs, in a manner quite different from ours. They would say that the advance of the Stars from West to East, being owing to the *Cranti-Pata-Gati* (the Hindu precessional variation), it is the moveable Sign *Aries* which has receded from the Constellation, or fixed Sign of the same name, with which it formerly coincided; and consequently, that the Zodiacal Sign *Aries* has fallen back into the fixed Sign *Pisces*, which comes precisely to the same thing. But more scientifically, they would say that the *Rishis* have got into some point of the moveable *Aries*; (vide *Rishis, Ayanansa, Cranti-Pata.Gati.*)—It needs hardly be added, that what is said here of the Solar Signs applies equally to the *Nacshatras*.—For the extraordinary *Nacshatra*, see *Abhijit*; vide p. 6, 73, 74, 176, 181, and Table XXXVIII.—*Nacshatra Chacra*; the Sphere of the fixed Stars.

NA'D'IMAND'ALA, (నాడిమండల)—(written in the Text *Narimandala*)—The Celestial Equator. Vide p. 5, 91.

NA'GAVA, (నాగవ)—The 10th and extraordinary *Carana*. Vide p. 75.

NANDANA, (నందన)—The 26th year of *Jupiter's* cycle. Vide Chr. Table I.

NARA', (నర)—The eternal omnipotent Being.

NARA'DIYA, (నారదీయ్య)—The name of an Astronomical work composed by *Narada*.

NARA'SIMHA, (నరసింహ్మ)—The 4th incarnation of *Vishnù* as a Lion. Vide p. 311.

NA'RA'YAN'A, (నారాయణ)—A name or incarnation of *Vishnù*.

NA'TA' (నత)—The arc of distance of any Planet from the Zenith.—*Natáns'a* or *Náta bhaga*, Zenith distance. Vide p. 91, 96.

NAVAMI; (నవమి)—The 9th Lunar day of the *Pacsha*. Vide p. 70.

NAZHI, or NA'SHICAY, (நாழி, நாழிகை)—A *Tamil* term meaning an Indian hour of time. Vide p. 71.

NELA, (నెల)—In *Telugu*, a month.

NERMADA, or NĀRMĂDA, (నర్మదా)—A great River called in our Maps the *Nerbudda*, which from time immemorial has marked the boundary between Hindustan and the Deckan. It takes its source near the Vindha mountain in the Province of Malwa and flows into the Sea near Surat. This river is the same as that which Ptolemy calls *Namadus*. The Indian name is a compound Sanscrit word, which signifies the river of delight; from *Nerma*, pleasure, and *Da*, she who bestows. Independently of the use made of this river in Geography, it serves also to separate two sects of Astronomers, who divide time on different principles. Thus whereas the *Vrihaspati* or Jupiter's year of the cycle of sixty, is reckoned at *Oogein* and *Benares*, and down to the Nerbudda, to be equal to the time during which that Planet describes one Sign of its orbit, in all the Deckan, down to Cape Comorin, it is taken to be equal to a Solar year. And whilst all the Northern Astronomers reckon the latter to be of 365^d 6^h 12′ 34″, agreeably to the doctrines of the Suryah Siddhanta, those who reside South of the Nerbudda make it only 365^d 6^h 12′ 30″: from this class, however, we must except that subdivision called the *Sittandij*, or inhabitants of the Southernmost part of the Peninsula, whose year differs only one second of time in *minus*, from that of the Northern Astronomers. Vide Pr. p. ix; Text, p. 7; the IIId Memoir from p. 199 to 216, and Chr. Table I.

NIJA, (నిజ)—Proper, self.—*Nija Aswina*, the proper month of *Aswina*, in contradistinction of *Athica Aswina*, the intercalated Lunar month. Vide p. 69, 72, 146, 342.

NIMESHA, (నిమేష)—The 1.3600th of an *Alipala* (vide *Alipala*), or the time for the twinkling of an eye. Vide p. 6.

NIRACSHA, (నిరక్ష)—The Terrestrial Equator.—*Niracsha désa*, the Equatorial parts of the Earth.—*Niracsha-pura*, the four fabulous cities supposed to lie under the Equator, of which *Lanca* is one. (Vide *Lanca*).

O

For *Opady*, thus wrongly written in the Text, see *Uphádi*.

P

PACSHA, (పక్ష)—Half the Lunar month.—*Sucla* or *Sudha pacsha*, the time from the new to the full Moon.—*Crishna* or *Bahula pacsha*, that from the full to the new Moon.—Each *Pacsha*, whatever be the real duration of the Lunar month, contains 15 *Tithis*, or Lunar days, each being called numerically, so that there are two *Tithis* of the same name in the Lunar month. Vide p. 68, 69, 314, 318.

PA′DA′, (పాద)—The fourth part.—The Quadrant of a Circle.—The *Pádás* of the *Ayanáns'a*; the four Quadrants of the Epicycle, or parts of the Arc described by the 1st point of the Tropical Zodiac in consequence of the precessional variation. Vide p. 84, 247, 248, 308, 313, and Tables XXXV and XXXVI, p. 46 and 47 of the Tables.

PA′DACHA′RUM, OR CHA′RUM, (పాదచారం)—(sometimes wrongly spelt in the Text *Isharum*)—A term used in the Kalendar and Ephemerides for signifying the position of the Planets on a particular day; being one of the five articles of the *Panchanga.* Vide p. 73, 75, 308.

PAD'YAMI, (పాడ్యమి)—The 1st day of the Lunar pacsha, or demi-month. Vide p. 70.

PALA, (పల)—A minute of time, Hindu account.

PALABHA, (పలభ)—The midday Shadow of a Gnomon, when the Sun is in the Equinoctial points. Vide p. 9, 94, and Table XXXIV, p. 45 of the Tables.

PANCHA BHUTA, (పంచభూత)—The five elements of Nature, including *Ether.*

PANCHA'NGA, (పంచాంగ)—A Kalendar so called from the five principal articles contained in the Ephemerides.

PARA, (పర)—A second of time, Hindu account, or 24″ European time.

PARA'BHAVA, పరాభవ)—The 40th year of the cycle of Jupiter. Vide Chr. Table I.

PARA BRAHMA, (పరబ్రహ్మ)—A name, or epithet of the Supreme Being.

PARAMA'PAMA, (పరమాపము)—The inclination of a Planet's orbit to the Ecliptic.—*Paramápama cramajya,* the Sign of its greatest Declination.—N. B. When this term is applied to the Sun, because according to Hindu theories the obliquity of the Ecliptic is always 24°, it means the Sine of the Sun's greatest declination.

PARA'S'ARA, (పరాశర)—An Astronomer who wrote when the Equinoctial points were in 23° 20′ of the Sign *Mesha.*—Modern commentators pretend that the *Parása'ra Siddhánta* is a spurious treatise, written by *Arya bhatta,* so late as the beginning of the XIVth century; and consequently cannot have been written by *Parás'ara,* who flourished about the year 575 before Christ.

PARAS'URA'MA, (పరశురాము)—One of the Avataras or incarnations of *Vishnù,* in the form of a Brahmin.—Modern commentators fix his epoch in the year 1176 before Christ. He is said to have been a great encourager of Astronomy.—Also an Æra which is still followed in *Malayálá* (that part of the Coast of Malabar which extends from Mangalore to Cape Comorin).—This Æra is reckoned in cycles of 1000 years; each of which begins on the Sun's entrance in the Sign *Canya* ♍ (Indian Virgo).—There were, therefore, on the 14th September 1800, two cycles, and 976 years of that Æra expired. Vide p. 298, 302, and of Chr. Tables p. vi, vii, & Table I.

PARATASI, or **PURATASI,** (புரட்டாசி)—The 6th Solar month, Tamil denomination, answering to the Hindu *Aswina,* when the Sun is in the Sign *Canya* ♍. Vide p. 5, and Table III.

PARIDHAVI, or **PARIDHA'PI,** (పరిధావి)—The 46th year of the cycle of Jupiter. Vide Chr. Table I.

PARIDHI, (పరిధి)—Properly means the circumference of a Circle; but it is more generally used in the sense of an Epicycle. Thus *Paridhi an'sás,* or *bhagas,* mean degrees counted on an Epicycle, always in a given ratio, to those of the Deferent.—The *Manda paridhi,* is used for computing the first inequality or Anomalistic equation of a Planet. It is variable, being called *Yugma* *paridhi* in the Apsides, and *Voja paridhi* at 90° therefrom.—The degrees of these divers dimensions of the Epicycle vary therefore relatively to those of the Deferent, as the Planet's Anomaly is between the points above mentioned, decreasing inversely as the Sines of the mean Anomaly. At the distance of 3 Signs from either the *Apogee* or *Perigee*, the radius of the Epicycle becomes equal either to the *eccentricity;* or to the Sine of the *elongation*, if it refers to an inferior Planet.—This assumed difference in the magnitude of the Epicycle, (and consequently of its degrees relatively to those of the Deferent) is what the Hindus call *Paridhi an'sá*, between *Vishama*, and *Sama* (odd or even); for a right application of which we are to remember that from the 1st to the 3d Sign of Anomaly, a Planet is in *Vishama*; from the 3d to the 6th, it is in *Sama;* from the 6th to the 9th, it is again in *Vishama*; and lastly, from the 9th to the 12th, it is in *Sama*.—The *Sighra paridhi* is used for computing the second inequality, answering to the annual *Parallax* of the superior Planets, and *elongation* of the inferior ones. This Epicycle is also variable, being called *Yugmantara paridhi* in the Sizigies, and *Vojantara paridhi* at 90° therefrom.—*Swa*, *Seva*, or *Siva-desa-paridhi*, a Circle of Longitude in any given Latitude. Vide p. 91, 95, and Table XXXIV.

PARIGHA, (పరిఘు)—The *Yoga* Star of the 19th Lunar mansion. Uncertain; but supposed to be 34 or 35 *Scorpii*. Vide p. 74.

* PA'RIJA'TA', (పారిజాత)—The Tree of Plenty.—In some parts it is taken to be an emblem of the year; but this is unknown to the Pundits of the Carnatic.

PA'RTHIVA, (పార్థివ)—The 19th year of *Jupiter's* cycle. Vide Chr. Table I.

PASCHA, or PASCHAMA, (పశ్చిమ)—The West point of the compass.

PA'TA, (పాత)—The Node of a Planet's orbit. Vide *Ayanansa* and *Dhruva*, also p. 86.

PATACA, (పతక)—An Astronomical Table.

PATANA, (పతన)—Latitude, when referred to the Planets.

PATRA, (పత్ర)—Literally, a *Leaf;* but used in several parts of India for *Panchanga*, a Kalendar; because these are usually published on *Palmyra* leaves. Vide Pr. p. vii, xii, and Text p. 312.

PAU'LASTYA SIDDHA'NTA—(పౌలస్త్యసిద్ధాంత)—The third of the four authentic *Sástras*, which treat of Astronomy.

PAUSHYA, (పౌష్య)—The 9th Solar Hindu month, when the Sun is in the Sign *Dhanus* ♐, answering to the Tamil *Margali*; vide p. 5 and Table III.—*Paushya* is also the 10th month of the Luni-solar year, so advanced by one in the order, on account of *Chaitra*, beginning that sort of year. Vide p. 69.

PAVARNAMI, or PURNIMA, (పౌర్ణమి)—The 15th Lunar day of the *Pacsha*. Vide p. 70.

P'HALA, (ఫల)—An Equation.—When applied specially to the Sun or Planets, it means their Anomalistic equation.—*P'hala try desentara*, is a compound equation used by the Tamil Kalendar makers for computing, by means of certain Tables, and a short operation, the *Arcá bahuphala*, and the effects of difference of Longitude in Solar and Lunar computations. Vide p. 38, 230, 338, and Tables XXII to XXVI for the Sun and Moon, and from XLI to XLV, part 2, for the Planets.

PHALGUNA, AND PHALGUNI, (ఫాల్గుణ)—*Phalguna* the 11th Hindu Solar month, when the Sun is in the Sign *Cumbh'a* ♒ ; answering to the Tamil *Maussi* ; vide p. 5, and Table III.—According to the Luni-solar Kalendar *Phalguna* is the 12th month of the year, because it begins with *Chaitra* ; vide p. 69.—*Purva* Phalguni the 11th, and *Uttara* Phalguni the 12th Lunar mansions. Vide p. 74.

PINDA' (పిండ)—The 1-24th part of the Quadrant of a Circle ; equal to 3° 45', the constant ratio of the Hindu Trigonometrical Tables. Vide p. 87 and Table XXX.

PINGALA, (పింగళ)—The 51st year of the cycle of *Jupiter*. Vide Chr. Table I.

PITRI, (పితృ)—Certain Genii or Spirits, supposed to reside in a sphere or region, some say above the Moon ; others residing in it. The *Pitris* are also taken to be the spirits of deceased ancestors.—*Pitrya dina* ; a day of the *Pitris* equal to a lunation.

PLAVA, (ప్లవ)—The 35th year of the cycle of *Jupiter*. Vide Chr. Table I.

PLAVANGA, (ప్లవంగ)—The 41st of the same.

PUNGONI, (పంగుని)—The 12th Tamil Solar month, answering to the Hindu *Chitra*, when the Sun is in the Sign *Mina* ♓. Vide p. 5, and Table III.

PRABHAVA, (ప్రభవ)—The 1st year of the cycle of *Jupiter*. Vide Chr. Table I.

PRAC CHACRA (ప్రాక్చక్ర)—The Epicycle on which ancient Astronomers corrected the precessional variation. Vide *Cranti-Pata-Gati*, and p. 84 of the Text.

PRA'JA'PATI, (ప్రజాపతి)—A name of *Brahma*.—An epithet common to 10 divine personages who were first created by *Brahma*.—*Pra'ja'pati*; the 5th year of the cycle of Jupiter; vide Chr. Table I.—*Prájápatya ma'na*, a certain mode of reckoning the year ; also, a *Manwantura*.

PRAL'AYA, OR JALA-PRALAYA, (ప్రళయము)—A name for the universal deluge.

PRAMADI OR PRAMADICHA, (ప్రమాదీచ)—The 47th year of the cycle of *Jupiter*. Vide Chr. Table I.

PRAMAN'A', (ప్రమాణ)—Refers to diurnal revolutions.—*Aha pramán'a* ; the Sun's revolutions from the horizon to the same again.—*Dina pramá'n'a*, the time of any Planet from rising to setting.—*Ratri prama'na'*, the same from setting to rising.

PRAMODA, (ప్రమోద)—The 4th year of the cycle of *Jupiter*. Vide Chr. Table I.

PRAMAT'HI, (ప్రమాధి)—The 13th of the same.

PRA'NA'CA'LA, (ప్రాణకళా)—The 1-6th part of a *vicala*. See *Múrta*, and p. 5, 77, 101.

PRATHAMA, (ప్రథమ)—The first.—*Prathama tithi*, the first Tithi or Lunar day in the month; that which always follows the day of last conjunction ; vide p. 70, 79, 108, 112, 137, 172, 229.—*Prathama chara*, Ascensional difference of the 1st Sign of the Hindu Tropical Zodiac ; vide p. 103.—The same for the Sun's declination and Amplitude ; vide p. 102, 103.—*Prathama jiva*, the Sine of the first *Pinda*. Vide p. 39 of the Tables.

PRI'TI, (ప్రీతి)—The *Yoga* of the 2d Lunar mansion, supposed 35 *Arictis.* Vide p. 74.

PUNARVASU, (పునర్వసు)—The 7th Lunar mansion. Vide p. 74.

PANCHAMI, (పంచమి)—The 5th Lunar day of the month. Vide p. 70.

* PURANA'S, (పురాణ)—Books held in high veneration by the Hindus, treating of Theology, Literature and Astronomy, and other matters, of which there are 18 principal ones: they take these productions, as usual, to be of the highest antiquity; but modern European commentators have been very active and industrious in their endeavours to bring down the epochs of their respective compositions nearer to our times. Many of the Puranás are now believed to be very recent, and one of them in particular is conjectured not to be above 100 years old.

PU'RNIMA', (పూర్ణిమా)—Opposition (sometimes written *Paurnimá)*—*Púrnima tithi,* the day of opposition or full Moon. Vide p. 67, 70, 313, 320, 339.

PURVA, (పూర్వ)—When referred to one of the Lunar mansions means the First, and in the same manner as *Uttara*, means the Second. Vide p. 74.

PURU, (పర)—The East point of the compass.

PUSHYA, పుష్య)—The 8th Lunar mansion, vide p. 74, where the word is sometimes wrongly spelt *Pushia.*

R.

RA'C'SHASA, (రాక్షస)—The 49th year of Jupiter's cycle. Vide Chr. Table I.

RACTACSHA, (రక్తాక్షి)—The 58th of the same.

RAGINI'S, (రాగిణి)—Spirits, or demi-goddesses personifying the notes of music.

RA'HU, (రాహు)—The Moon's ascending Node.—In a physical sense the Hindus consider it as one of the obscure Planets, which occasion Eclipses: but according to mythology, *Ra'hu* is the head of a monster, of which *Cétu* (the descending Node, spelt *Ketu* in the Text) is the trunk.—It is supposed by some commentators to be the *Typhœus* of Hesiod. Vide the war of the Súras and Asúras in the Mahábhárata), also p. 77, 308, 310, 340.

RA'MA', (రామ)—The principal of the *Avatu'ras*, or descents of *Vishnu*; a great conqueror, and the Prince whose reign forms the most important epoch of Indian history.—Sir William Jones places the subjugation of India by *Ra'ma'* about the year 1810 before Christ. Mr. Bentley, after a much more accurate research, fixes his birth on the 6th April of the year 961 before Christ. In his time and that of his father *Das'aratha*, Astronomy was much cultivated; and it is supposed (not without much probability) that the first Astronomical Tables for computing the places of the Planets were constructed on the observations made in *Ra'ma'*'s time. There was an Eclipse of the Sun on the 2d of July of the year 940 before Christ, which, according to Mr. Bentley, may be referred to with certainty, as an epoch of *Rámá's* reign.

RA'MA'YANA, (రామాయణ)—(of Válmíci)—An historical poem, being one of the principal ones (viz:

the *Rámáyana*, the *Bhágavata*, and the *Ma'ha'bha'rata)* which have been transmitted to posterity. It gives an account of the epochs of the sway, and dynasties of Princes; of the wars and battles (true or fictitions) which have been fought during their time, and of the heroes who have shed a lustre over their reigns; of the revolutions which the country has undergone; and of the origin and progress of the sciences in the infancy of time. - Modern European commentators fix the epoch in which the *Ra'ma'yana* was written in A. D. 295; professing however, their belief that the events which it records are of much higher antiquity.—In the *Ra'ma'yana, Valmici* is repeatedly mentioned as the name of its author.

RA'MI'SWARA, or RAMA.ISWARA, (రామేశ్వర)—(written in the Text *Ramissuram*, and *Ram.Ishura)*—Is a small island, situated between Ceylon and the Continent of India, at the entrance of Palk's passage in the Streights of Manaar; where there stands a very ancient Pagoda, and formerly an Observatory.—It was found by Colonel Lambton's survey to lie in 79° 22′ 5″ (5h 17′ 28″ 20‴) Longitude of Greenwich; in 77° 1′ 50″ (5h 8′ 7″ 30‴) East of Paris, and consequently in 3° 28′ 50″ (14′ 55″ 20‴) East of *Lanca:* its Latitude being 9° 18′ 7″ N.—Many Telugu, and Tamil Astronomers, as *Báládityacalu*, and *Mallicárjanad'u* refer their computations to the Meridian of *Rámiswara*. Vide p. 9, and Tables **XXXIII** and **XXXIV**.

RASA GI RICA, (రసఘిరీక)—(written in the Text *Raza Gherica*)—An element of the *Vac'yam* process, containing 12372 days. Vide p. 122, 132, 133, 335.

RA'S'I, (రాశి)—A Sign of the Zodiac, containing 30 degrees.—Modern European commentators state that the Stars were only formed into Constellations during, or at the epoch of the war of the *Sura's* and *Asúras*, which, according to them, refers to the middle of the VIIIth century before Christ.—A *Rás'i* is equal to 2¼ *Nacshatras* or Lunar mansions.—The Hindu Signs are called by specific names when reckoned on the *Sydereal* Zodiac; but when counted on the *Tropical*, or movable Sphere, they are called numerically. The figurative description of the Hindu Signs with the corresponding Lunar mansions, are as follows:

1, Aswiní, Ram ♈; 2, Crîticà, Bull ♉; 3, Mrigasírsha, Pair ♊; 4, Pushya, Crab ♋; 5, Asléshà, Lion ♌; 6, Uttara Phalguni, Woman ♍; 7, Swati, Balance ♎; 8, Anúrádhà, Scorpion ♏; 9, Múla, Bow ♐; 10, Uttara Ashadha, Sea Monster ♑; 11, Dhanishtha, Ewer ♒; 12, Purva Bhadrapada, Fish ♓.—*Ras'i Chacra*, the Zodiac. Vide p. 5.

RA'TRI, (రాత్రి)—The night.—*Ra'tri ardha;* half the artificial night. Vide p. 92, 106.—*Tyajya Ratri*, (vide *Tyajya Devi*).

RAVI, (రవి)—A name of the Sun.—*Ravi vara*, Sunday; vide p. 6, and Tables XX, XXII, XXIV, XXVII, XXVIII and XLVII.—*Ravi mandocha*, Sun's Apogee, p. 83; *Ravi madhya graha*, mean place in the Sydereal Ecliptic, p. 83; *Ravi panchanga*, the Solar Kalendar, p. 63, 307, 313; *Ravi p'hala*, Anomalistic Equation, p. 128; *Sayana*, Longitude, p. 101.

RAUCHYA, (రౌచ్య)—One of the 14 Patriarchs who are supposed to preside successively over the 14 *Manwantaras* of the *Calpa*, and whose anniversaries are noticed in the Kalendar. Vide p. 311.

RAUDRA, (రౌద్ర)—The 54th year of the cycle of *Jupiter*. Vide Chr. Table I.

RAYAVATA, (రైవత)—One of the 14 Patriarchs who are supposed to preside over the 14 *Manwantaras* of the *Calpa*, and whose anniversaries are noticed in the Kalendar. Vide p. 311.

REC'HA, (రేఖ)—Meridian.—Used in the same sense as Europeans do when referred to the Longitude. Vide p. 9, and Table XXXIII.

REVATI, (రేవతి)—The 27th Lunar mansion. Vide p. 19, 74.

RICSHA, (ఋక్ష)—Properly a Bear.—In Astronomy the general term for a constellation, (vide Nacshatra).—*Maha-Ricsha* may therefore be understood either as the constellation of the *Bear*; or as the *great constellation*. Whether the former denomination (which is the same as the name given by Europeans to the asterism called the *Great Bear*) be merely accidental; or whether by that term, both Europeans and Hindus, mean the same object, is a question which is not to be resolved in this place. In *Telingana* it is affirmed that it does: in the *Carnatic* it is denied; we have therefore only to observe that as the *Great Bear* is the most prominent constellation of the Northern hemisphere, it may very well (and without any reference to the animal of which it bears the name) be concluded that *Maha Ricsha* means the same object both in European and in Indian Astronomy. Vide p. 85, 245.

RINA, (ఋణ)—The Indian Sign of negation, or subtraction, which answers to the European — minus.

RISHI (ఋషి)—An important term in Hindu Astronomy, which, in its scientific sense, means a line, or great circle, passing through the Poles of the Ecliptic, and the beginning of the first Solar Sydereal Sign, and first fixed Lunar mansion, of the respective Zodiacs; and which said circle is supposed to cut some of the Stars in the Great Bear, which most commentators take to be *Dhube*, or β *Ursæ Majoris*, and ζ *Piscium*, although in reality no such circle could be made to intersect exactly these three points. This line, or circle, being thus invariably fixed, and the four (fixed and moveable) Zodiacs being conceived to coincide at a particular Epoch, the variation of the moveable ones may easily be reckoned by its means, as if it were an index. Thus suppose that the line of the *Rishis* should have intersected the beginning of the fixed Lunar mansion *Magha*, as was supposed to be the case in the 1910th year of the Cali yug (1192 before Christ), and that at the beginning of the said year the line of the *Rishis* was found by observation to intersect the middle of the moveable mansion *Magha*, then it would be said truly that the *Rishis* had got into 6° 40′ ($\frac{13^\circ 20'}{2}$) of the moveable *Magha*, and these 6° 40′ would mark the absolute precessional variation which had accumulated at that epoch since the time that the fixed and moveable *Maghas* coincided; (vide *Ayana*, *Ayanansa*, *Cranti-Pata-Gati*).—The above explanation of the term *Rishi* is clearly justified by all the Hindu treatises of any weight which have hitherto fallen into the hands of Europeans; and here it may not be out of the purpose to observe, that when *Hipparchus* (later than the 135th year before Christ) on comparing his observations of *Spicæ Virginis* (the *Harshana* of the

Indians) with those that *Timocharis* had made at Alexandria about a century before, and perceived by the results, that the Stars appeared to have advanced (though slowly) from West to East, relatively to the Equinoctial points, he was far from imagining that Indian Astronomers (perhaps several centuries before his time, and in all probability by observations of the same Star) had already noticed the same variation, on which in after ages Sir Isaac Newton resolved and established the great problem of the Equinoctial precession.—The celebrated Indian Astronomer *A'rya bhatta*, probably puzzled how to account for the change of the position of the line of the *Rishis* which, he admitted, had intersected the middle of the moveable Lunar mansion *Magha* in the year of the *Cali yug* 1910, and which he pretended to cut (when he wrote) the beginning of *Aswini*, imagined a curious system on the seven Stars of the Great Bear, to which he supposed *a proper* motion to the Eastward, at the rate of 13° 20′ (a Lunar mansion) in 100 years; which amounted to 159999 revolutions in a *Calpa*, and which squared his account. But this absurd doctrine has long since been abandoned by all manner of Indian Astronomers; many of whom, now in existence, have never heard of it.—The term *Rishi* is also applied (in a sense totally different) to the *Van'aprastha* Brahmins, or inhabitants of the desart. Of these the most ancient and celebrated were the seven great *Rishis* or penitents, who had retired in the territory washed by the Indus; and it was to them, it is supposed, that Alexander the great applied for instruction after invading their country. Vide p. 85, 245.

RĬTU, (ఋతు)—A season, of which there are six of two months each in the Solar year, (vide *Vasanta, Grishma, Varsha, Sarada, Hemanta* and *Sisira.*) Vide p. 4.

RO'HINI', (రోహిణీ)—The 4th Lunar mansion. Vide p. 74.

ROHITACA, (రోహితక)—A mountain or place lying under the Meridian of Lanca.

ROMACA, (రోమక)—One of the four imaginary cities lying under the Equator. Vide *Lanca.*

RUDIRO'DGARI, (రుధిరోద్గారి)—The 57th year of *Jupiter's* cycle. Vide Chr. Table I.

RUDRA SAVARNI,—(రుద్రసావర్ణి)—(The same explanation as for *Rauchya*). Vide p. 311.

RUG, RUC, or RIG VEDA, (ఋక్, ఋగ్వేద)—The first of the inspired Vedas. *Rig*, signifying the science of divination, of which it principally treats. It also teaches Astronomy, Astrology, Natural Philosophy, and gives a particular account of the formation of matter, and the creation of the world.

RU'PA, (రూప)—An entire number.

S

SA'CA, (శక)—An epithet given to a Prince to whose name posterity refers an Æra. (Vide *Salivahana).*

SA'CHA, (శాఖ)—Department; branch of knowledge.

SADHA'RANA, (సాధారణ)—The 44th year of *Jupiter's* cycle. Vide Chr. Table I.

SA'DHYA, (సాధ్య)—The *Yoga* Star of the 22d Lunar mansion, *α Aquilæ*, Vide p. 74.

S'A'LIVA'HANA, (శాలివాహన)—The name of a Prince who is said to have reigned in a country called *Magadha.*—He instituted, or was the cause of the institution of an Æra, which bears his name, the beginning of which is referred to the epoch of his birth. This event is supposed to have taken place when 3179 years of the *Cali-yug* had expired, which makes it fall 78 years after the beginning of the Christian Æra.—The *Saca* year is the same as, and begins with, the common Solar year. Vide p. 18, 203, 222, 228, 293, 296, 302, 303, and of Chr. Table p. vi, Table I.

S'A'LMALA,—(శాల్మల)—An island lying East of *Lanca*, supposed to be *Ceylon.*

SAMA AND VISHAMA, (సమ, విషమ)—Literally *even* and *odd* (vide *Paridhi*, and *Paridhi ansa*).—*Sama mand'ala ch'háyá*, the Shadow of a Gnomon when the Sun is East or West of it. Vide p. 97.

SAMA'GAMA, (సమాగమ)—The occultation of a Star.

SAMARGA, (సమార్ఘ)—A term used in the Kalendar to denote a middle state of abundance; neither favourable nor unfavourable to the productions of the Earth. Vide p. 312, 313.

SAMVATSARA, (సంవత్సర)—A *year*: chiefly applied to the Luni-solar year. Vide *Mana*; also p. 71, 77, 153.

SA'MA VE'DA, (సామవేద)—The 3d of the inspired *Vedas*. This book treats of all religious and moral duties: It also contains many hymns in praise of the Supreme Being, as well as verse in honor of the gods.

SANCRA'NTI, (సంక్రాంతి)—The day on which the Sun enters a new Sign of the Ecliptic.

SA'NCU, (శంకు)—A Gnomon for Astronomical purposes. The Pillars which are erected in front of every Pagoda are real Gnomons. Vide p. 91, 92, and Table XXXIV.

SANDHI, OR SANDHYA, (సంధి, సంధ్యా)—The Twilight or Crepuscule. The Sandhy of Brahma consists of 1728000 Solar Sydereal years; the same duration as the Crita, or Satya-yug, which quantity is used in its double capacity for constructing the *Calpa.*—*Prátas sandhya*, the morning twilight.—*Sáyam sandhya*, the evening do.—N. B. The twilight of each *yug* is equal to 1-6th part of the same. Vide p. 78.

SANCHYA' GAN'ITA, (సంఖ్యాగణిత)—Algebra (vide *Katapayadi*).

SANGAMA, (సంగమ)—Conjunction. (Vide *Arcéndu sangama.*)

SANHITA, (సంహితా)—A treatise on any branch of knowledge.

SANI, (శని)—A name of *Saturn*: the most common of all; vide p. 6, 189.—*Sani-vara*, Saturday.

SANLHITA SARAH, (సంహితాసార)—One of the ancient cities which are stated in books on Hindu astronomy, to lie under the same meridian with *Lanca* and *Ujani.* Vide p. 9.

S'ARADA, (శరత్)—The 4th season, comprehending the months of *Aswina* and *Carticay*, when the Sun is in the Signs *Canya* ♍ and *Tula* ♎; answering to the Tamil months *Paratasi* and *Arpesi.* Vide p. 4.

SARVADHA'RI, (సర్వధారి)—The 22d year of Jupiter's cycle. Vide Chr. Table I.

SARVAJIT, (సర్వజిత్)—The 21st year of Jupiter's cycle.—Vide Chr. Table I.

SARVARI, (శార్వరి)—The 34th of the same.

SA'STRA, (శాస్త్ర)—An inspired, or revealed book: this term is also applied to works of literature and science in general. Those which treat particularly of astronomy, are distinguished by the additional name of *Jyótish.*

S'A'STRI, (శాస్త్రి)—A *Pundit*, one skilled in the *Sastras.*—N. B. This word is always wrongly written *Sastras* in the Text.

S'ATABHISHA, (శతభిష)—The 24th Lunar mansion. Vide p. 74.

SATYA YUG, (సత్యయుగ)—The same as the *Crita yug.* The golden age of the Hindus; the first period of the four contained in a *Maha yug.* Its duration is of 1728000 Solar Sydereal years. Vide p. 7, 77, 78.

SA'VANA (BHU'MI), (సావన)—Natural—which refers to the Earth (written *Sávan* in the Text). Vide p. 79, 80, 81, and article *Sávana dina.*

SA'VARNI, (సావర్ణి)—An epithet, or cognomen, annexed to the names of five of the Patriarchs who preside over the 14 *Manwantaras* of the *Calpa.* Vide p. 311.

SAUBHA'GYA, (సౌభాగ్య)—The *Yoga* Star of the 4th Lunar mansion. Uncertain; but may be 87 *Tauri.* Vide p. 74.

SAUMYA, (సౌమ్య)—The 4th year of *Jupiter's* cycle. Vide Chr. Table I.

SAURA, (సౌర)—Sydereal. Vide p. 1, 5, 77, 202, and article *Mana.*

SA'YANA, (సాయన)—The Longitude of a Planet reckoned from the Vernal Equinoctial point, as is the practice of European Astronomers. This element depends on the *Cranti-Pata-Gati,* and is calculated by means of the *Ayanansa,* which latter element being added to the Planet's *Sphuta graha* (its apparent place in the Hindu Sydereal Zodiac) gives its *Sayana,* or apparent Longitude. For a fuller explanation of this term see the two articles above referred to, and p. 71, 91, 101, 130.

* SEPTAMI, (సప్తమి)—This term when affixed to the name of one of the Signs of the Zodiac, indicates the day on which the Sun enters the same. Thus *Macara septami* means the day on which the Sun enters the Sign *Macara* ♑: it is little known to the Pundits of the Carnatic.

SEVA, OR SIVA-DESA PARIDHI, (స్వదేశపరిధి)—The circumference of a Circle of Longitude in any point on the Globe of the Earth, removed from the Equator; or, as Europeans would say, which has Latitude.—The degrees of these small circles of the Sphere are taken by the Hindus to be in the direct ratio of the cosines of the Latitudes; and resolved into assignable quantities from the dimensions of the Equatorial circle, which they take to contain 5059 *yojanas*; vide p. 91, 95, Table XXXIV, and article *Yojana.*—*Seva desa madhya paridhi;* the circumference of the Terrestrial Equator.—*Seva desa wydia,* a term, (it seems obsolete) for the oblique ascension of a Planet; (vide *Ullagna*).—N. B. This element is important in the resolution of all *Gnomonic* Problems; and for fixing the Longitude of places. Vide article S of the Second Memoir, p. 90.

SHUSTI, (షష్ఠి)—The 6th Lunar day of the *Pacsha*. Vide p. 70.

SIDDHA, (సిద్ధ)—The *Yoga* Star of the 21st Lunar mansion. Uncertain; perhaps Φ *Sagittarii*. Vide p. 71.

SIDDHI (or ASRIJ) (సిద్ధి)—The *Yoga* Star of the 16th Lunar mansion; perhaps 24 *Libræ*. Vide p. 74.

SIDDHANTA', (సిద్ధాంత)—literally signifying *Demonstrated, established truth*; also a *conclusion*. In Astronomy; a treatise on that science. There is a numerous train of treatises of this kind, of which four only are reputed to be of divine origin, viz.: 1º The *Suraya*; 2º The *Brahma*; 3º The *Paulastya*; 4º The *Soma* Siddhantas.—*Parására*; *Varáha*, and his son; *Bháscara* and others have left *Siddhántas* and *Ticas*, which are now in repute. But doubts have arisen whether the *Parására Siddhanta* which exists, be a legitimate or spurious production. Mr. Bentley decides for the latter and believes it to have been forged by *A'rya bhatta*.

SIDDHAPURY, (సిద్ధపురి)—One of the imaginary cities which are supposed to lie under the Equator at 90° from each other. (Vide *Lanca*).

SIDHARTI, సిద్ధార్థి—)—The 53d year of *Jupiter's* cycle. Vide Chr. Table I.

SI'GHRA, (శీఘ్ర)—Answering to what European Astronomers call *Parallax*; (vide *Chaturtha p'hala*, and *Virdhamanda p'hala*).—*Sighra chaturtha*, the same as the last.

SINHA, (సింహ)—The Hindu Solar Sign Leo ♌.

SIS'IRA, (శిశిర)—The 6th season of the year, comprehending the Hindu Solar months *Mágha* and *Phalguna*, when the Sun is in the Signs *Macara* ♑, and *Cumb'ha* ♒, answering to the Tamil months *Tye* and *Maussi*.

SITTANDIJ, (సిద్ధాంతి)—A term used by Father Beschi to designate a certain sect of Astronomers who reside in the Southern parts of the Peninsula. It is unknown to the Madras Pundits.

SIVA, (శివ)—The third person of the Hindu triad, and the principal personification of time. The forms and names which this godhead assumes are without end, and therefore shall be passed over.—*Siva* is also the *Yoga* Star of the 20th Lunar mansion and supposed to be the same as δ *Sagittarii*. Vide p. 74.

S'LO'CA, (శ్లోక)—A verse: a memorial couplet: also a technical rule for computing certain astronomical problems, delivered in verse in the *Suryah Siddhanta*.

SO'BHANA, (శోభన)—The *Yoga* Star of the 5th Lunar mansion. Very uncertain; but may be 113, 116, or 117 *Tauri*; vide p. 74.—*Sóbhana* means also the 37th year of *Jupiter's* cycle. Vide Chr. Table I.

S'ODHYA, (శోధ్య)—called SOBHACRITU in the Carnatic, (శోభకృతు)—(wrongly written *Sodhyum* in the Text)—A constant number to be *subtracted* in certain computations, to fit the rule to a particular epoch, being the negative of *Cshépa*, which see. Vide p. 54, 65, 81, 119, 210.

SOMA, (సోమ)—A name of the Moon.—*Soma vara*, Monday. Vide p. 6.

SPHUTA, (స్ఫుట)—(wrongly spelt in the Text *Sputa*).—True, or apparent; in contradistinction of *Madhyama*, or mean.—*Sphuta ravi*, or *Chandra graha*, or *gati*, true or apparent place or motion of the Sun and Moon, in the Sydereal Zodiac. Vide the whole context of the second Memoir.

SPRĬC, OR SPROHU, (స్పృక్)—(wrongly written in the Text *Sprohu* or *Sprohoo*)—A Lunar intercalary day repeated during two successive Solar days in the Kalendar.

SRAVANA, (శ్రావణ)—The fourth month of the Hindu Solar year, when the Sun is in the Sign *Carcatáca* ♋, answering to the Tamil *Audi*; vide p. 5, and Table III. Also the 5th month of the Luni-solar year, owing to that sort of year beginning with *Chaitra*; vide p. 60.—*Srávana*, the 22d Lunar mansion. Vide p. 74.

SRI', (శ్రీ)—The *Venus* Aphroditus of the *Indians*, born like the *Grecian* Venus from the Sea. (See *Lacshmi*, and *Crishna*).—*Sri-Crishna* is the 9th, and *Sri-Rama* the 7th incarnations of *Vishnu*, as a *Cshetria*, and a *Dwarf* Brahmin, the anniversaries of which are observed. Vide p. 311.

SRI'MUC'HA, (శ్రీముఖ)—The 7th year of *Jupiter's* cycle. Vide Chr. Table I.

SRISTYADI DIUGONA, (సృష్ట్యాదిద్యుగణ)—(spelt Strostidi Digona in the Text.) The number of natural days expired from the grand astronomical epoch when the Planetary motions are supposed to have first commenced, to any other epoch for which their places are to be computed. Vide p. 79, 80, 81, 82, 243.

STHITYAR'DHA, (స్థిత్యర్ధ)—The time from the beginning of an Eclipse to its middle.

STHIRA, (స్థిర)—A general term for the 4 extraordinary *Caranas*. Vide *Carana*, and p. 75.

STHU'LA, (స్థూల)—(Vide *Múrta*.)

SU'BHA, (శుభ)—The *Yoga* Star of the 23d Lunar mansion, α *Delphini*. Vide p. 74.

SUBHACRIT, (శుభకృత్)—The 36th year of *Jupiter's* cycle. Vide Chr. Table I.

SUBHANU, (సుభాను)—The 17th of the same.

SUCARMA, (సుకర్మ)—The *Yoga* Star of the 7th Lunar mansion, β *Geminorum*. Vide p. 74.

S'UCLA, OR SUDHA, (శుక్ల, శుద్ధ)—The 1st or enlightened half of the Lunar month.—The 3d year of *Jupiter's* cycle. Vide Chr. Table I.

SU'C'HI, (సూచి)—The Earth's disc in computing Eclipses.—The fourth term of a proportion, which is to the Moon's equated motion, as the diameter of the Earth, is to her mean motion. This proportion serves in the computation of Lunar Eclipses, to adapt the Earth's shadow, to the Moon's distance and apparent diameter.

S'UCRA, (శుక్ర)—One of the names of the Planet *Venus*.—*S'ucra-vara*, Friday.—*S'ucra* or *Subra*, the Yoga Star of the 24th Lunar mansion, perhaps λ *Aquarii*. Vide p. 74 and Table XLIV.

S'UDDHA COTI', (శుద్ధకోటి)—One of the sides of a right angled Triangle; the second being sometimes called *Bhuja*, and the hypothenuse *Carna*. Vide p. 91, 94.

S'UDDHA DINA, (శుద్ధదిన)—(wrongly spelt *Soota dina* in the Text)—The day on which a particular phænomenon is to occur. Vide p. 8, 79, 81, 83, 243, 244, and Tables XLVIII and XLIX.

SU'LA, (శూల)—The Yoga Star of the 9th Lunar mansion. Uncertain; perhaps 49 or 50 *Cancri*. Vide p. 74.

SUME'RU, (సుమేరు)—The Northern hemisphere.—A fabulous region over the North Pole, where *Indra* is said to preside over the *Súras* or *Devatas*. (Vide *Cuméru*).

SU'NYA'RGA, (శూన్యార్ఘ)—A term meaning *scarcity*; or a time unfavourable for agricultural undertakings, which occurrence is, from time to time, predicted in the Kalendar. Vide p. 312.

SUPTAMI, (సప్తమి)—The 7th day of the Lunar *Pacsha*. Vide p. 70.

SURÁ, (సుర)—A measure of time equal to the 1-60th part of a *para*, which see. Vide also p. 6.

SURABHI, (సురభి)—The mythological *Cow* that grants every boon in allusion to the Spring.

SURA DEVI, (సురదేవి)—The goddess of wine: sometimes used figuratively to signify the year.

SURA'S, (సరాః)—Benign spirits governed by *Indra*, harbouring about the North Pole, who with the *Asuras* churned the ocean, and extracted the *Amrïta* or water of immortality, pending which a furious war broke out among them, in which *Vishnu* took a part, as well as *Surya* and *Chandra*, who were the occasion that *Rahu's* head was severed from its trunk by the irresistible operation of *Vishnu's chacra*; all which allegories figure an Eclipse of the Sun, which occurred near the Moon's ascending Node. (Vide *Devatas* and *Asúras*).

SU'RYA, (సూర్య)—The name most generally given to the Sun (vide *Ravi*).—*Súrya savarni*, one of the 14 Patriarchs who preside successively over the 14 *Manwantaras* of the *Calpa*. Vide p. 311.

SU'RYA SIDDHA'NTA, (సూర్యసిద్ధాంత)—The first (though not the oldest) of the authentic and inspired *Sastras*, held in great veneration by all manner of Hindu Astronomers, although they acknowledge that its elements, without the assistance and use of the tikas, or commentaries, no longer furnish means for representing the true positions of the Planets. It is pretended that this book was revealed 1000 years before the beginning of the *Treta yug* (A. 3027101 Ante Christum).—European commentators, however, have all agreed to reduce considerably this enormous antiquity, though they still differ vastly in their opinions touching its true epoch; some supposing it to have been written 2050 years before Christ (i. e. 93 years after the Flood), others in the 1208th year of the Christian Æra. Mr. Bentley, however, seems to have proved, after a very profound research, that let the antiquity of the *Suryá siddhánta* be what it may, it only came into general use in A. D. 538.—Vide the whole of the second Memoir of the *Kala Sankalita*, and particularly p. 7, 17, 63, 69, 90, 199, 200, 239, 246, 325, 329, and Tables XVII, XLVIII and XLIX.

SU'TRA, (సూత్ర)—A rule, a precept, a computation.

SWA RO'CHISHA, (స్వారోచిష)—One of the 14 *Patriarchs* who preside over the 14 *Manwantaras* of the *Calpa*, noticed in the Kalendar. Vide p. 311.

SW'ATI, (స్వాతి)—The 15th Lunar mansion. Vide p. 74.

SWA'YAMBHUVA, (స్వాయంభువ)—One of the Patriarchs as stated, article *Swárôchisha*. Vide p. 311.

T

TADYA, (తదియ)—The 3d Lunar day of the *Pacsha*. Vide p. 70.

TA'MASA, (తామస)—One of the 14 Patriarchs (vide article *Swárôchisha*).

TAMIL, (తమిళ్)—The name of a language, and of an extent of country where that idiom is in general use (spelt *Tamul* in the Text), and for which the Solar Kalendar *(Ravi Panchanga)* is computed. Several European writers, and particularly Missionaries, speak frequently in their books of the *land of Tamil*, as if it were delineated upon the Map of India, like the territory of a particular state; but I am perfectly satisfied that none of them entertained any distinct idea of the country they were speaking of. The obscurity into which this designation is involved, has induced me to make some researches of the probable position and extent of the land under consideration; and what follows is an abstract of my information.(*)—" The *Tamil* land is the same with *Dravira*, " and comprehends all the districts in which that language is spoken, enclosing a portion of the " Eastern parts of the Peninsula."—" When *Dravira* was confined to the *Chola Pandya*, and " *Chera* principalities, its Northern boundary was the *Pal-aur* river. When the Chola Princes " colonized *Tondamandula*, it was extended Westward to *Tripeti*, in a line with *Puliat*, at " which some pretend that the land of *Dravira* was met by that of *Tellingana*. Other autho" rities however, extend it to the North, up to the river *Chrishna*; and the latter supposition " agrees best with our modern notions of the Geography of the country." But if we attempt to estimate the extent of the land of *Tamil* by that through which the language of that name is spoken, we fall into the region of conjectures, some of which, however, may be grounded on what follows: " The Indian dialects which originated in Sanscrit, are said to be ten; viz. " 1º The sacred language used by the Priests and *Bhudists* in the Island of Ceylon. 2º The " *Tamulic*, spoken in the Deckan and some parts of the Malabar Coast. 3º The *Malabar*, " extending from Cape *Comari* (Comorin) to Mount *Illi* (Dilly), which separates Malabar from " Canara. 4º The *Canarian*, used in the districts of *Illi* and thence to *Goa*. 5º The *Marattah*, " spoken by the various nations of that republic. 6º The *Telugu*, (Tellinga) used on the " Coast of Orixa, and in Golconda (the Nizam's territory), down to the river *Chrishna*. 7º The " *Bengalese*, spoken in the province of Bengal. 8º The *Hindustanee*, which is principally used " in the upper provinces of the Bengal Presidency, but known throughout India, where it has " become an intermediate means of communication between people speaking different languages. " 9º The *Guzuratic*, introduced into *Guzurat*, *Baroach*, *Surat*, *Tattu*, &c. 10º The *Nepalic*, " of which eight dialects are spoken in *Nepal*."—What is stated in the second article of this enumeration, agrees well enough with the former Geographical description. We may therefore

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(*) These particulars were obligingly communicated to me by Dr. Wilson of Calcutta, and Captain D. Montgomerie, Deputy Surveyor General in India.

take the *land of Tamil* (when that term happens to be used in a general way) to mean that extent of country which begins on the Southern banks of the river *Chrishna*, and dividing from thence the Peninsula into two nearly equal parts, descends on the East, down to Cape Comorin.

TAMUS, (తమస్)—The Earth's shadow in an Eclipse.

TA'RANA, (తారణ)—The 18th year of *Jupiter's* cycle. Vide Chr. Table I.

TATPARA, (తత్పర)—(wrongly written *Tarpary* in the Text)—A space of time; the same as *Para*. Vide p. 71, 131, 132, 339.

TAYTALA, (తైతుల)—(written *Dhitalu* in the Text)—The 4th regular *Carana*. Vide p. 75.

TE'DI, (తేది)—(Telugu and Tamil)—A date, according to Solar account—(wrongly written in the Text *theidi*). Vide p. 73, 77, 164, 313.

TELUGU, (తెలుగు)—(written in the Text *Tellinga*)—The land of *Telingana*, which is now partly subject to the British power, and partly to that of the *Nizam*, is bounded to the North by the river *Godavery*; to the East, by the Sea; to the South by the river *Chrishna*; and to the West by the river *Manujera*, which runs into the *Godavery* at *Sungum*. The *Telugu* language is prevalent throughout that extent of land; therefore when *Telugu* or *Tellinga* Astronomers are mentioned in the Text, those of the said countries are to be understood; and the same of the *Telugu year* and Kalendar, when so specifically named, although that year be in fact the common *Chandra mana*, which is more or less prevalent in all parts of India. Vide Pr. p. vii, viii; Text p. 61, 164, 204, 304, and article *Tamil*.

TI'CA', (టీకా)—A commentary.—Most of the *siddhantas* which have been written by modern Hindu authors, such as the *A'rya*, *Parás'ara*, and other treatises known by that designation, as well as the *ticás* of *Bháscara A'chárya*, *Varáha Mihira*, and others, may be considered as commentaries on the four principal *siddhantas*.

TITHI, (తిథి)—(wrongly spelt *Tidhi* in the Text)—The 1.30th part of the time which the Moon takes to move through a Synodical revolution, whatever be its true duration.—It is also considered as the time during which the Moon's motion to or from the Sun amounts to 12°.—A mean *tithi* (of which there are 371 very nearly in the Solar year) is equal to $59^g\ 3^v\ 38^p$ of Hindu time ($23^h\ 37'\ 27'',2$ European time); so that 64 mean *tithis* are very nearly equal to 63 Solar days, and this difference of one day, in the said period of time, is the occasion of the *Cshaya*, or expunged *tithis*, which in the Kalendars are called *Amavaha* or *Spr'ic* (wrongly spelt *Sprohoo* in the Text) and which recur once in about 64 days.—When no *tithi* begins or ends in a Solar day, the preceding *tithi* is repeated in the Kalendar, and the same numeral answers to two Solar days: it is then called *Athi* or *Athica*.—When two *tithis* end in the same Solar day, the intermediate *tithi* is expunged and called *Cshaya*.—The 30 *tithis* of the Lunar month are divided in two parts, called *Pacshas*, of 15 tithis each. (See article *Pacsha*).—The first *tithi*, independently of its proper name *Pád'yami*, is also called *Prathama*; and the last (*Pacarnami*) *Amavásya*, meaning that it is the tithi on which the conjunction falls.—The 15th tithi (also called *Pavarnami*) is distinguished by the name of *Púrnimá*, meaning that it is the day of opposition. Vide p. 60, 70, 72, 76, 90, 109, 112, 117, 164, 172, 307, and of Chr. Tables p. xvii and Table II.

TITHI TATWA, (తిథితత్వ)—A particular Kalendar which marks all the fasts, religious observances, and ceremonies prescribed on certain days of the year.

TRAYO'DAS'I, (త్రయోదశి)—*The 13th Lunar day of the Pacsha.* Vide p. 70.

TRE'TA YUG, (త్రేతాయుగ)—The 3d period of a *Maha yug* used in the construction of the *Calpa;* the Hindu silver age, consisting of 1296000 Solar Sydereal years. Vide p. 7, 77.

TRIDI SPRĬC, (త్రిదినస్పృక్)—(wrongly written in the Text *Tridina sprohoo*). Vide articles *Sprĭc* and *Athica.*

TRĬJYA, (త్రిజ్యా)—A term answering to *Radius*, being the Sine of 3 Signs or 90°. Vide p. 101, also *Duajya*, p. 28.

TRIN, or **TRAIRA'S'ICA**, (త్రైరాశి)—A rule of proportion.—The common rule of three; constantly used in the resolution of Problems of Hindu astronomy.—N. B. This rule is to be found in almost every article of the two first Memoirs.

TRICO'NA, (త్రికోణ)—A Triangle.

TRIVALORE, (తిరువాలూరు)—A village in the Tanjore province, to which certain Astronomical Tables refer. According to the Hindu Geography, it lies 3° 32′ 58″ E. of Lanca in Longitude, and in 10° 44′ N. Latitude. Vide Tables XXXIII and XXXIV.

TULA, (తులా)—The 7th Sign of the Hindu Sydereal Zodiac, *Libra* ≏. Vide p. 5 and Table III.

TUNGA, UCHA, (తుంగ, ఉచ్చ)—Superior, higher.—*Tunga manda*, or *Manduacha;* the superior Apsis or Aphelion of a Planet. Vide p. 83, 84.

TYA'JYA', (త్యాజ్య)—(wrongly spelt in the Text *Thyajum* and *Thyagum*)—That portion of a *Nacshatra*, which is deemed unlucky, is called *Varjya*, and the period of its duration is the *Tyájyá.*—It is called *Devi* when it occurs at day time; and *Ravi* when at night. It is therefore an *astrological* element: but is nevertheless registered every day in the Ephemerides; where the instant of its commencement is registered. Its mean duration is about 4 guddias (1^{h} 36′ European time), so that the beginning being known, the end may be supported, with sufficient accuracy for practical purposes, without actual computation. Vide p. 75, 181, 307, also article *Varjya.*

TYE, (తై)—The 10th *Tamil* Solar month, answering to the Hindu *Mághá*, when the Sun is in the Sign *Macara* ♑. Vide p. 5 and Table III.

V

* **VACIJ**, (వాకిజ్)—Spelt in the Text *Vachij*, after Father Beschi's orthography.—This term, like that of *Sittandij*, is unknown to the Madras Pundits, but it is unquestionably used in the provinces of

Madura and Tinnivelly to designate a particular sect of Astronomers who reside in the Northern parts of the land of Tamil; vide p. 7 and Table I.

VAIDHRITI, (వైధృతి)—The *Yoga* Star of the 27th *Nacshatra* or Lunar mansion, ζ *Piscium*; vide p. 19, 74, 215.

VAISA'CHA, (వైశాఖ)—The first month of the Hindu Solar year, when the Sun is in the Sign *Mésha* ♈, answering to the Tamil *Chitram*. Vide p. 5 and Table III.

VAJRA, (వజ్ర)—The *Yoga* Star of the 15th Lunar mansion, *Arcturus*. Vide p. 74.

VAKYAM, (వాక్య)—(as written in the Text, but according to adopted system *Vacyam*)—The Solar process for all manner of astronomical computations; vide the whole of the second part of the 2d Memoir, from p. 118 to 148.—*Vacyam dharmavana*, an element of this process, being the remainder after division of the *Ahárgana* by a *vedam*, *rasa-gérica*, *cálánila* and *dévaram*, which remainder, expressing a number of days expired of the current *dévaram*, is the argument for using the first *vaciam* table (the XXVIth of this collection). Vide p. 19, 118, 122, 132, 133, 230, 336, and Tables XXVI, XXVII, XXVIII and XLVII.

VA'MANA', (వామన)—One of the incarnations of *Vishnù* in the form of a *Brahmin Dwarf*; the anniversary of which is noticed in the Kalendar. Vide p. 311.

VANATA'NS'A, (వనతాంశ)—(as spelt in the Text, but according to our orthography *Avanatansa*)—Altitude.—*Avanatansa bhágas*, degrees of altitude of an object above the horizon.

VA'RA, OR VA'SARA, (వార, వాసర)—A week of seven natural days, named after the Planets and arranged in the same order as they are in the European week. The name of each day (beginning with Sunday, and adding *vara* to each) are, 1º *Ravi*. 2º *Sóma*. 3º *Mangala*. 4º *Budha*. 5º *Guru*. 6º *Sucra*. 7º *Sáni*.—The tabular notation of the feriæ, or days of the week is, 0 for Sunday, 1 for Monday, and so forth to 6 for Saturday; 7 being accounted zero. Vide p. 6.

VARA'HA, (వరాహ)—One of the incarnations of *Vishnù*, in the form of a *Wild Hog*, the anniversary of which is noticed in the Kalendar; vide p. 311.—An Astronomer, the reputed author of a system of Astronomy referred to in the *Súrya*, *Vasist'ha*, and *Sóma* Siddhantas, and therefore supposed by modern *Sastris* to be anterior to them all. But European commentators entertain a belief that the work which goes by *Varaha's* name in present times, is not the real one; and that the treatise which has reached us, is a fabrication of no older date than the IXth century.—*Varáha Mihira*, another Astronomer, thought by many to have been cotemporary with the Emperor *Acbar*; but whom others are apt to confound with *Varáha Acharya*, and others of the same name.—N. B. The *Telugu* Astronomers pretend that *Varáha Mihira* flourished in the 3600th year of the *Cali yug* (A. D. 499), i. e. at the close of the 2d *Padah* of the *Ayanansa*, when the Sun, Moon, and Equinoctial points (according to the doctrines of the *Surya Siddhanta*) were in the first point of the Hindu Sydereal Zodiac; or, in other words, when the *Rishis* were in the 1st point of the Solar Sign *Mesha* ♈, and in the same of the Lunar mansion *Aswini*.

VARGA, (వర్గ)—See *Varga*.

VARI'YA, (వరీయా)—The *Yoga* Star of the 18th Lunar mansion, *Antares*; vide p. 74.

VARJYA, (వర్జ్య)—(wrongly spelt in the Text *Wurjum*)—A certain point in each *Nacshatra*, or Lunar mansion, called its *Dhruva*, determines the duration of this astrological element; and the time which the Moon's disc takes to move across this ill-omened point, is called the *tyajyá*; the mean duration of which is about 4 ghadyas of time ($1^h\ 36'$ E. T.); but its true duration is greater or less according to the Moon's continuance in the incumbent *Nacshatra*, which depends on her position relatively to her *Apogee*, and determines whether her stay in the mansion be more or less than 60 *ghadyas*.—The *tyájyá* of the *varjya* is always punctually registered in the Ephemerides of the Kalendar, of which it is one of the five permanent articles, by stating the time of its *beginning*. Pending its duration, all voluntary business of importance must remain suspended; but as the instant of its ending is not announced in the Kalendar, people calculate generally on 4 ghadiyas of inaction from the beginning of the *varjya*.

VARSHA, (వర్ష)—The third season of the Hindu Solar year, comprehending the months of *Sravana* and *Bhadrapada*, when the Sun is in the Signs *Carcata* ♋ and *Sinha* ♌, answering to the Tamil months *Audi* and *Auvani*; vide p. 4.

VASANTA, (వసంత)—The first season of the year, comprehending the Solar months *Chaitra* and *Vaisac'ha*, when the Sun is in the Signs *Mina* ♓ and *Mesha* ♈, answering to the Tamil months *Pungoni* and *Chitram*; vide p. 4.

VAVILALA CUCHINNA, (వావిలాల, కొచ్చన్న)—A Telugu Astronomer who is supposed to have flourished in the 4399th year of the *Cali yug*. He has left some tables for computing the position of the Planets, and some tracts on the construction of the Luni-solar Kalendar, of which the Appendix to the second Memoir of this collection is one. These are much esteemed by the Astronomers in *Telingana*. Vavilala's computations refer to the meridian of *Lanca*, and agree better with the doctrines of the *Surya Siddhanta* than those of any of his compatriots; vide p. 81, 153, 167, the Appendix to the 2d Memoir, and the Tables from XLI to XLV.

VA'YU, (వాయు)—The Atmosphere.

VE'DAM, (వేదం)—An element of the *vacyam*, or Solar process; containing 1600984 days; vide part 2, second Memoir, and p. 122, 132, 133, 335.

VE'DAS, (వేద)—The inspired books, four in number, viz. 1° The *Rig*; 2° The *Sáma*; 3° The *Yajur*; 4° The *Atharvana vedas*. (For the particulars of each, see the respective terms).

VE'DHEI, FOR VETHEI, (వేధ)—An astrological element, an account of which is given at pages 76, 308 and 309 of the Text, and noticed in all the Ephemerides.

VELLI′, (వెళ్లి)—The Tamil name of *Venus.*

VI-ARCE′NDU SANGAMA, (వ్యర్కేందు)—(wrongly spelt in the Text *Vi-arca-Indu, Sangama)*—Conjunction of the Sun and Moon. Vide p. 70, 89, 90 ; also *Arcéndu Sangama).*

VIASSEI, (వైయాశి)—The 2d Solar Tamil month, answering to the Hindu *Jaisht′a*, when the Sun is in the Sign *Vrisha* ♉ ; vide p. 5 and Table III.

VIBHAVA, (విభవ)—The 2d year of Jupiter's cycle ; vide Chr. Table I.

VICALA, (వికలా)—The 1-60th part of a *cálá*. The second of a degree.

VICARI, (వికారి)—The 33d year of the cycle of Jupiter ; vide Chr. Table I..

VICRAMA, (విక్రమ)—The 14th year of the same.

VICRAMA′DITYA, (విక్రమాదిత్య)—A Prince who has given his name to an Æra, and who is said to have flourished 135 years before *Sálivâhana*. Its epoch falls when 3044 years of the Cali yug had expired. The Æra *Vicramaditya* is little used in the Peninsula of India, although its current year be generally inserted at the head of the Kalendars.—In those provinces where it is current, it serves to number the Luni-solar years, in the same manner as the Æra *Salivahana* in the Carnatic for the Solar ones ; vide p. 18, 293, 295, 302, 303, 313, 318, and of the Chr. Tables p. xii, and Table II.

VICRITA, (వికృతి)—The 24th year of *Jupiter's* cycle ; vide Chr. Table I.

VI′CSHEPA, (విక్షేప)—Celestial Latitude (vide *Patana).*—*Vicshepa Dhruva*, the greatest inclination of a Planet's orbit ; vide Parama′pama and p. 74, 91, 342.—*Vĭcshepa pataca cala.* See Table at p. 342.

VIDIYA, or **DWITYA**, (విదియా, ద్వితీయా)—The second Lunar day of the *Pacsha* ; vide p. 70, 112.

VIGHAD′IYA, (విఘడియా)—(spelt in the Text *viguddiu)*—The 1-60th part of a *ghadiya ;* an Indian minute, equal to 24 seconds European time.

VIJAYA, or **VIJYA**, (విజయ)—The 27th year of *Jupiter's* cycle ; vide Chr. Table I.

VILAMVA, or **VILEMBI**, (విళంబి)—The 32d of the same.

VILIPTA, (విలిప్తా)—See *Vicála* and *Múrtu).*

VIMARDHA′RDHA, (విమర్ధార్ధ)—The time from the apparent conjunction to the end of an Eclipse. (Vide *Sthityardha).*

VINADICAY, (వినాడికా)—The 1-60th part of a *nashicay* ; vide p. 5, 71.

VIPALA, (విపల)—The same as a *pranaca′ld′*, the 1-6th part of a *pala* ; vide p. 5.

VIRDHAMANDA P′HALA, (వృద్ధమందఫల)—The equation of the second inequality in the motion of the inferior Planets. (Vide *Sighra* and *Sighra Chaturtha).*

VIRO′DHACRIT, (విరోధికృత్)—The 45th year of *Jupiter's* cycle ; vide Chr. Table I.

VIRO′DHI, (విరోధి)—The 23d of the same ; vide do.

VISA′CHA, (విశాఖ)—The 16th Lunar mansion ; vide p. 74.

VISHAMA, (విషమ)—A Planet is said to be in *vishama* when it is in 90° from the *Apsides.*—The Sun is in *vishama,* when he is in the Equinoctial points.—*Vishama ch'háyá,* the Shadow of the Gnomon at midday when the Sun is in the *Equinoxes,* (vide *Palabha*).—*Vishama carna,* the hypothenuse of a right angled triangle formed by the *Sancu* (Gnomon) and the two sides of the Shadow ; vide *Sama* and *Paridhi,* also p. 91, 94.

VISHCAMB'HA, (విష్కంభ)—The *Yoga* Star of the 1st Lunar mansion; supposed to be γ or β *Arietis;* vide p. 74.

VISHU, (విషు)—The Tamil name for the 15th year of *Jupiter's* cycle,—the same as *Brisya.*

VISHNU', (విష్ణు)—The second person of the Hindu triad,—the preserving power, too well known to be further particularized.—*Vishnù* is often taken as a personification of *time,* as well as *Siva;* vide p. 311. —*Vishnu dhármeottara,* a treatise on astronomy.

VISHUVA, (విషువ)—The Equinoctial points, called also *Ayanas, Dhruvas,* and *Cranti-Patas.*—*Vishuva dina,* the day of the Equinoxes.—*Vishuva ch'háyá,* the Shadow of the Gnomon at noon on those days ; vide *Vishama,* and p. 84, 313.

VISHWA'VASU', (విశ్వావసు)—The 39th year of *Jupiter's* cycle ; vide Chr. Table I.

VISTI, (విష్టి)—(spelt *Vusti* in the Text.)—A name for the 7th and ordinary *Carana,* also called *Bhudra;* vide p. 75.

VRIDDHI, (వృద్ధి)—The *Yoga* Star of the 11th Lunar mansion ; very uncertain ; perhaps 70 or 71 *Leonis:* vide p. 74.

VRIDDHYARGHA,(వృధ్యర్ఘ)—A term used in the Kalendar to signify *Abundance; Plenty.*—It also means the time favourable for agricultural operations *(astrological);* vide p. 312.

VRĬHASPATI, or VARAHASPATI, (బృహస్పతి)—One of the most common names of the Planet *Jupiter.* —*Vrĭhaspati chacra,* the cycle of 60 years which gives a specific name to all the Solar and Luni-solar years.—*Vrĭhaspati mana,* the year of *Jupiter,* during which he describes one sign of his orbit.—N. B. The *Telugu* Astronomers make no difference between this and the common Solar year ; vide p. 70, 147, 195, 212, 296, 303, and the Tables from XI to XIX ; also Chr. Table I.

VRISHA, వృష)—The Solar Sign *Taurus* ♉ ; vide p. 5 and Table III.

VRISCHICA, (వృశ్చిక)—The Hindu Solar Sign *Scorpio* ♏ ; vide do.

VRITHAM, (వ్రతం)—Fast, or day of fasting ; vide p. 311.

VURGA, (వర్గ)—(so spelt in the Text, but perhaps more correctly *Varga.*)—The square of a number.—*Varga múla* or *meta,* the square root of the same ; vide p. 343.

VYAYA, (వ్యయ)—The 20th year of *Jupiter's* cycle ; vide Chr. Table I.

VYA'GHATA, (వ్యాఘాత)—The *Yoga* Star of the 13th Lunar mansion : uncertain ; perhaps 7 or 8 *Corvi.*

VYANGULA', వ్యంగుళ)—The 1-60th part of an *angulá,* or digit (wrongly spelt in the Text *vincula*)—A measure used in the computation of Eclipses, and *Gnomonic* Problems.

VYA'SAM, VISHCAMBHAM, VISTRITI, (వ్యాసం)—Terms used to express the diameter of a circle.

VYATI'PA'TA, (వ్యతీపాత)—The *Yoga* Star of the 17th Lunar mansion, β *Scorpii.* Vide p. 74.

VYWASWATA, (వైవస్వత)—One of the 14 Patriarchs who preside successively over the 14 *Manwantaras* of the *Calpa.* Vide p. 311.

U

UCHA, (ఉచ్చ)—The Apses of a Planet's orbit. (Vide *Mandócha.*)

UJANI, (ఉజ్జయని)—(wrongly spelt in the Text *Ujjayini*)—A city under the same meridian as *Lanca;* supposed to lie near the modern town of *Oogein.* Its Longitude from Greenwich, is therefore 75° 35' 16" E. Its Latitude is 23° 11' 30" North. Vide p. 9.

ULLAGNA, ఉల్లగ్న)—The *Lagna* of a particular place; answering to the oblique ascension of the asters, in any place which has Latitude; vide p. 92, 101, 103, 104, where the *Ullagna* of Madras is given for every Sign of the Zodiac; and Table XLVI, for the Latitude of 16° 15'.

UPHA'DI, (ఉపాధి)—(wrongly spelt in the Text *Opadi*)—A term referring to the Luni-solar Kalendar, and meaning an expunged day. Vide *Tithi;* also p. 72, 311.

UTPA'TA, (ఉత్పాత)—Some natural prodigy or phænomenon.

UTTAMA, (ఉత్తమ)—One of the 14 Patriarchs who preside successively over the 14 *Manwantaras* of the *Calpa.* Vide p. 311.

UTTARA, (ఉత్తర)—(wrongly spelt *Vutra* in the Text)—The North point.—When Uttara is prefixed to the name of a *Nacshatra,* it means the second of the same name. (Vide *Purva.*)

UTTARA JYA, (ఉత్తరజ్యా)—The versed Sine of an Arc. Vide Table XXX.

W

WARNIJA, (వణిజ)—(spelt in the Text *Warnaji*)—The 6th and ordinary *Carana.* Vide p. 75.

WURJUM, (వర్జ్యం)—See *Varjya.*

WUTRAJYA, (ఉత్తరజ్య)—An element of Hindu Spherical Trigonometry. Vide p. 99, and for the demonstration p. 42 of the Tables.

Y

YAJUR VE'DA, (యజుర్వేద)—The second of the inspired *védas,* which comprehends the whole science of religious rites and ceremonies, such as fasts, festivals, purifications and sacrifices.

YAMA, (యమ)—The godhead who presides over the *Asúras* or *Daityas.* (Vide *Devatas*).

YAVA COTI, (యవకోటి)—One of the four imaginary cities supposed to lie under the Equator at a distance of 90° from each other, *Yava-coti* being West of *Lanca.* Vide p. 9.

YECADASI, (ఏకాదశి)—The 11th Lunar day of the *Pacsha.* Vide p. 70.

YO'JANA, (యోజన)—An Astronomical and Geographical measure, deduced from the ratio of the diameter of the Earth to the circumference of its Equatorial circle. The dimensions of the *yójana*, like those of any other measure, originate in an arbitrary division of extent, for which the Hindus have chosen a finger or *angulá*, as a standard to be found in nature. By that common measure they estimate not only distances, and the dimensions of the Earth, but even the distance of the Planets, their Parallaxes, and (when referred to particular points on the surface of the Earth) the effects of their Longitude and Latitude as to time. The Hindu Mathematicians divide the diameter of the Earth into 1600 parts, whence they have this expression $\sqrt{10 \times 1600^{2}} = 5059{,}6$ yójanas for the value of the Equatorial circle. An angle of one minute of a degree is supposed to be subtended by 15 yójanas, at the mean distance of the Moon; so that dividing the Earth's semi-diameter (800 yójanas) by 15, we have 53′ 20″ for the Moon's mean *horizontal parallax.* It follows from this result that 53′ 20″ of the Moon's orbit will measure 15 yójanas, and that her whole orbit (360°) will measure 324000 yójanas. Hence 5059 (the circumference of a great circle of the Terrestrial Globe in yójanas) is to 800 yójanas (its semi-diameter), as 324000 (the circumference of the Moon's orbit in *yójanas*) is to 51235 yójanas her mean distance from the Earth: from which it follows that this distance (according to the estimates of Hindu Astronomers) is about 64 semi-diameters of the Earth.—As the Moon is supposed to complete 57753336000 Sydereal revolutions in a *Calpa*, this number drawn into 324000, gives 18712080864000000 *yójanas* for her absolute motion during that time.—It is a principle in Hindu Astronomy "That the *absolute motion* of each *Planet* in a day, or any other "given time, is equal to the *absolute motion* of the *Moon* in the same time."—Hence if the absolute motion of the Moon during a *Calpa*, be divided by the number of mean revolutions completed by any Planet, during that period, it will give the *Cacsha*, or circumference of the Planet's orbit in *yójanas*.—To convert degrees of Latitude and Longitude into *yójanas*, they use the following proportion: "As 360°; to the proposed number of degrees; so 5059 *yójanas* (the "circumference of the Equatorial circle), to the number of yójanas sought."—The Hindus subdivide the *yójana* into a great number of parts, in the following manner: The *yójana* ÷ 4 *crosas* ÷ 1000 *dhanush*, or *dandas* ÷ 4 *restas*, or *cubits* ÷ 2 *vilistis*, or *spans* ÷ 2 *padas*, or *foot* breadths ÷ 6 *angulas*, or *finger* breadths ÷ 4 *yaras*.—Some make the *crosa* = 2000 *dandas*, or half a *yójana*, which agrees better with that in which the distances are usually computed. Vide Art. 8, Sect. I of the 1st Part of the 2d Memoir, p. 92, and the 2d Fragment, p. 330.

YECJYA, (ఏకజ్య)—(Vide *Duajya, Trijya*).

YO'GA, (యోగ)—The leading or principal Star of a Lunar mansion, the position of which is given in the Hindu Astronomical Tables.—On these we shall only observe that in taking the Latitude and Longitude of Stars, as laid down in these catalogues, the former is to be considered as an arc of the meridian which intersects the *Star* and the *Ecliptic*; and the latter as the portion of the *Ecliptic* which is intersected by the same meridian, and the Equinoctial *Colure*. There are 28 *Yoga* Stars (including *Abhijit*) in the Lunar Zodiac: but with the exception of 16 or 17 of these (on the identity of which there can be little doubt), it is very uncertain to which of the Stars in the European catalogues, the remainder corresponds.—*Harshana* (which no doubt is the same as our *Spica Virginis)* seems to be the *Yoga* which drew most the attention of the ancient Hindu Astronomers; probably on account of its convenient magnitude, and declination; which at the beginning of the IXth century was 9° 38′ 13″ S.—To this Star they referred the beginning of the 7th month of their Solar Sydereal year, from which they concluded its beginning; and there is every reason to suppose that it was on the result of observations of *Harshana* that they established their *Cranti-Pata-Gati*, or precessional variation; a surmise which, if correct, offers a singular concurrence of circumstances, for it was by observations of the same Star that *Hipparchus* first discovered (in the IId century before Christ) the motion of the fixed Stars from West to East; vide p. 19, art. 9.—*Yōgu*, a term so pronounced by the Telugu Astronomers, and thus written in the Text, but *Yoga* as spelt by the Carnatic *Sastris*, is an astrological element, containing the same number of accidents as there are *Yogas* in the 27 regular mansions of the Lunar Zodiac; bearing the same names, and arranged in the same order; but having *no sort of Astronomical reference* to them.—A *Yogù* is the time during which the sum of the motions of the Sun and Moon, amounts to one *Nacshatra*, or 13° 20′. Its mean duration is $59^g\ 29^v\ 21^p,75$ Indian time ($23^h\ 47'\ 41''\ 24'''$ European time); 17 of which are nearly equal to 16 days; which occasions an equation somewhat similar to that of the *Cshaya tithi* (which see). Vide p. 7, 19, 74, 77.

YOGHADI PATACA, (యోగాది-పఠక)—The second Table of the *Vacya* process (the XXVIIth of this collection), giving the equation of the Sun's motion, considered at the rate of 1 degree for a day, to his true motion for every 8th day in the year. Vide p. 124 and following.

YUDHISHT'HIRA, (యుధిష్ఠిర)—A Prince of great celebrity in Hindu history, who according to Indian authors, reigned about the beginning of the *Cali yug*; some, however, fix the epoch of his reign 653 years later, or in the year 2448 before Christ. He is said to have been cotemporary with the Astronomers *Parására*, and *Garga*.

YUG, or YUGA, (యుగ)—Signifies properly the conjunction, and sometimes the opposition of the Planets. It is, however, more generally used for signifying a long period of years, at the expiration of which certain phœnomena, or circumstances, recur.—The principal *Yugs* made use of in present times in Astronomical computations, have been mentioned and explained under the respective heads of *Maha yug*, *Satya*, *Treta*, *Dwapara*, and *Cali yugs*, and need not be repeated in this article.—It is, we believe, generally admitted that ancient Astronomers invented their *Yugs* with reference to some of *Jupiter* and the *Sun's* conjunctions, in the beginning of the Zodiac; and that more recent ones, (with a view to lengthen their periods), have referred them to those of *Saturn* and the *Sun.*—But modern European commentators have made such prodigious alterations in the epochs and durations of these *Yugs*, without changing their names, that we shall not attempt to follow them in a Glossary, which was only intended for facilitating the reading of the present work, and the study of modern Hindu Astronomy, with reference to that system of Chronology, which was followed in India since *at least, thirteen* centuries, an estimate which is by no means overrated, even if we adopt the opinions most unfavourable to the antiquity of the *Surya Siddhanta*; vide p. 7, 77.—*Yuga dina* (sometimes written *yugadia)* means the anniversary of the day on which the current *Maha yug*, and any one of the four lesser *Yugs* began; which anniversary is always noticed in the Kalendar.—*Telugu* Astronomers use sometimes the term *Yugadia*, for *Ahargana.* Vide p. 240, and Chr. Table II.

YURKA, or **GURUJAH,** (యుర్కా, గరజ)—The 5th and ordinary *Carana.* Vide p. 75.

YUVA', (యువ)—The 9th year of *Jupiter's* cycle. Vide Chr. Table I.

END OF THE GLOSSARY.

INDEX

Of Arabic, Persian, Hebraic, and Hindustance words, and terms, used in the Kala Sankalita.—N. B. *The orthography is that of the French* Chronologers *of the last century.*

The languages are distinguished by A *for Arabic*, P *for Persian*, H *for Hebraic, and* Ind. *for Hindustanee.*

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On the Hindu Holy days and Festivals.

I SHALL offer but a few words on this subject, which has long since been laid before the public by Sir William Jones in his translation of *Raghunandana's* tract, containing an account of the rites and ceremonies observed generally by the Hindus during the course of the Luni-solar year. (*) My sole motive for enumerating these epochs anew, was to comply with the wishes of several Pundits with whom I had intercourse during the present research, and who conceived that my account of their various Kalendars would be incomplete if the present article were omitted.

I have compared the present list with that given in the *Tithi Tatwa*; and with the only exception that the latter is much fuller, and consequently more satisfactory than the present one, I have found no material difference between them. The variations which occur are to be ascribed to local customs and circumstances; and therefore the present catalogue must be especially referred to the inhabitants of the Carnatic, although the same observances may be kept in other parts of India.

Of the fixed and moveable feasts.

These words are to be understood in their literal sense when referred to the respective Kalendars on which the festivals depend; but not so when these are compared, or referred to the European Kalendar.

Thus for instance the festival of Sríráma-navamí, always falls on the ninth Tithi of the first Pacsha, of the Lunar mooth Chaitra, and therefore, in as much as the *Chandra Panchangum* is considered, it is a *fixed* holy day. But it is clear that it must occur sooner or later every year, when referred to the *Ravi Panchangum*, according as the beginning of the *Lunar* falls nearer or farther from that of the *Solar* year.

The Hindus of the Carnatic observe 37 principal feasts during the course of the Luni-solar year; 32 of which are fixed, and 5 are moveable, in the sense above explained.

Besides these, there are five holy days governed by the Solar Kalendar: four of which are determined by the Epocha when the Sun is in the *Equinoctial* and *Solstitial* points of the *Sydereal* Ecliptic. The fifth is only one of recreation. The natives of these Provinces observe, therefore, forty-two holy days in all.

Of the holy days which are governed by the Luni-solar Kalendar.

1. *Yugadi Pundaga.*—The 1st Tithi (Lunar day) of the *Chandra Sumvatsara*, called *Siddhanta Chandra mana* in the Carnatic, and reckoned in Bengal according to the style of Vicramaditya.

2. *Sríráma-navamí.*—The 9th Tithi of the 1st Pacsha of the Lunar month Chaitra; which is the anniversary of the incarnation of Vishnù in the shape of a Rajah, or Prince of the cast of *Cshetria.*—A day of prayer and recreation, though some devout Brahmins keep fast.

(*) Vide Asiatic Researches, vol. III, p. 257.

3. *Madana-trayódasí.*—A festival in honor of *Cáma déva* the god of love. This is observed on the 13th Tithi of the 1st Pascha of the Lunar month *Chaitra*; but principally in the Northern Provinces.

4. *Chittera Pavurnami.*—The 15th Tithi or day of full Moon in Chaitra, on which day *Chittere Gup'ta* (the recording spirit of Yama's chancery) is commemorated.

5. *Balarama Jayenti; Acsháyá Tritiya.*—The 3d Tithi of the month Vaisác'ha, 1st Pacsha.—N. B. When certain days of the Moon fall on certain days of the week, they are called *Acsháyás*, or *imperishable*. The present festival is subject to this contingency; but it is not considered so in the Carnatic.—This Tithi is the anniversary of the beginning of the *Tréta yug*; and a day of recreation.

6. *Nrĭsinha*, or *Narasimma Jayenti.*—The 14th Tithi of the 1st Pacsha of the Lunar month Vaisá'cha; being the anniversary of Vishnù's incarnation as half a lion, and half a man.

7. *Vyasa Pavurnami* or *Dánamá vasyacam.*—The 15th Tithi or full Moon of the Lunar month *A'shád'ha*, kept in commemoration of *Vyasa* (one of the *Avataras*). He was one of the most celebrated Penitents, and the reputed author of the 18 principal, and 18 inferior *Puranas*, and also of all the *Mantras* or forms of prayer, in existence.

8. *Garudá Punchami*; or *Nága punchami.*—The 5th Tithi of the Lunar month *Srávana*, on which day the serpent of *Vishnù* is worshipped.

9. *Vara Lacshmi Vrittum.*—(Moveable). This holy day is always kept on the Friday which precedes the *full Moon* of the Lunar month *Sravana*, reserved for Lacshmi's worship.

10. *Rugoopah Curmum.*—(Moveable); to be observed on the day when the Moon is in the Nacshatra *Sravana*. The Brahmins begin to read the Rig veda on this day.

11. *Ejurupa Curmum.*—The 15th Tithi, or day of full Moon of the Lunar month *Sravana*. On this day most of the Brahmins renew their sacrificial chord; and begin to read the Ijur veda.

12. *Crishna Jaumáshtamí.*—The 8th Tithi of the 2d Pacsha of the Lunar month *Sravana*. The anniversary day of *Vishnù's* incarnation into the person of Sri.Crishna.

13. *Somapa Curmum.*—The 3d Tithi of the 1st Pacsha of the Lunar month *Bhadrapada*; on which the Brahmins who follow the doctrines of the *Sama veda* renew their sacrificial chord; and begin to read that *veda*. (*)

14. *Vinayaka*, or *Ganésa Chaturt'hí*; also *Heritálicà.*—The 4th Tithi of the 1st Pacsha of the month *Bhadrapada*. An inauspicious day; because *Crishna* was falsely accused in his childhood to have stolen a gold gem from *Praséna* on that day.

15. *Rĭshi panchami.*—The 5th Tithi of the same month and Pacsha, on which the memory of the seven principal *Rĭshis* or penitents is commemorated.

16. *Ananta Chaturdasi.*—The 14th Tithi of the same month and Pacsha; sacred to Vishnù, under the epithet of *infinite*.

17. *Maha laêyaramba*, or *Aparapacsha*, and *Bráhma sávitri.*—The 1st Tithi of the 2d Pacsha

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(*) The Athara veda, is either supposed to be lost, or to be concealed as a bad book; and therefore never read (at least avowedly) by the Brahmins.

of the Lunar month *Bhádra*, on which the Hindus begin to worship the *Pitris*, or spirits of deceased ancestors.

18. *Madhya Astami.*—The 8th Tithi of the same Pacsha and month; a day on which it is maritorious to observe the *Srardum*, which when done, produces the same effect as if that ceremony had been performed during every other day of the Pacsha.

19. *Cali-yugadi.*—The 13th Tithi of the same month and Pacsha; being the anniversary of the beginning of the *Cali yug*.

20. *Navarátrïcam*, or *Aswina Sudham.*—The 1st Tithi of the month *Aswina*, consecrated to the worship of the goddess *Durgá*. On this day the *Dussera* feast is celebrated. It is one of the most important and splendid of the year.

21. *Saraswati Puja rumbha.*—(Moveable); to be observed on the day when the Moon is in the Nacshatra *Mula* in the 1st Pacsha of the month *Aswina*. On this day all Hindus begin to collect their books, and the instruments of their trade and profession, for the purpose of future adoration.

22. *Saraswati Puja*, or *Mahánavamì.*—The 9th Tithi of the 1st Pacsha of *Aswina*; a day of devotion; bathing and reading certain *Mantras*.

23. *Vijayá Desami.*—The 10th Tithi of the same Pacsha and month; on this day are worshipped all the books, arms, and instruments of trade which were collected on *Saraswati Puja rumbha*.

24. *Naraca chaturdasi*, or *Bhúta chaturdasì Yamaterpanam.*—The 14th Tithi of the 2d Pacsha of the month *Aswina*, on which *Yama* (the judge of the dead) is worshipped: the ceremonies performed on this day begin with the morning twilight or Pratha *Sandhya*.

25. *Dipavali*, or *Lacshmí pujá dipánwitá.*—The 15th Tithi or day of full Moon of the month *Aswina*. On this day the Hindus begin to wear new clothes, and on that occasion entertain their friends: this is also the epoch for settling accounts, and hoarding up treasure. At midnight all the votaries of *Lacshmi* shut up their money in a coffer, and worship it in honor of their tutelar goddess.

26. *Scanda-shasti.*—The 6th Tithi of *Cartica*, 1st Pacsha. A day of fasting in honor of *Subramania*, son of *Siva*.

27. *Crita Yugadi* or *Durgá navamì.*—The 9th Tithi of the 1st Pacsha of the month *Cartica*; and the anniversary of the beginning of the *Crita yug*.

28. *Utt'hánaicádasí.*—The 11th Tithi of the 1st Pacsha of the same month, the anniversary of that on which *Vishnù* awoke from his slumber of 4 months: a day for contemplation.

29. *Survalaya Deepum*, or *Dánamávasyacam.*—The 15th Tithi, or time of full Moon of the month *Cartica*: on this day all the pagodas and private houses are illuminated, and the rich entertain their friends.

30. *Cártica Deepum.*—(Moveable); this festival depends on the day on which the Moon is in the Nacshatra *Critica* during the month *Cártica*: it is a day of fasting in commemoration of *Subramania*.

31. *Moocoti Yacadesi.*—The 11th Tithi of the 1st Pacsha of the month *Margasiras*. A general

fast to be observed in honor of *Vishnù*, and kept all the day and night: no one should indulge in sleep during the whole course of the Tithi.

32. *Radha*, or *Bascara Septami*.—The 7th Tithi of the 1st Pacsha in *Magha*. A fast in honor of the Sun, as a form of *Vishnù*.

33. *Bishma Yacadesi*, or *Bhaimi*.—The 11th Tithi of the 1st Pacsha in *Mágha*. Ceremonies to be performed with *Tila* or *Sesamum*, in honor of *Bhima*.

34. *Maha Siva Rátri*.—The 14th Tithi of the 2d Pacsha in *Mágha*. A rigorous fast to be kept, with extraordinary ceremonies in honor of *Siva-linga*, the *Phallus* of the Indians.

35. *Dwapara yugadi*.—The Amavasya or conjunction day which determines the end of the Lunar month *Magha*, being the anniversary of the beginning of the *Dwápara yug*.

36. *Camadahánum Holica*, or *P'halgutsava;* vulgarly called *Huli*.—The 15th Tithi or full Moon of the month Phalguna. This festival was ordained on account of the near approach of the Vernal Equinox. All classes of Hindus sport on this day in honor of Govinda, who is carried about in a palankeen. It may be compared to the *Saturnalia* of the Romans, for all classes of Society are confounded whilst it lasts.

37. *Pungoni Uttara*.—(Moveable); this festival, which is kept in commemoration of the marriage of Siva, Vishnù and other gods, is to be kept on the day when the Moon is in the Nacshatra Phalguni. On the above account this day is held auspicious for marrying.

Solar Festivals.

1. *Varsharumbum*.—The beginning of the Solar Sydereal year; kept therefore on the 1st day of the month Vaisác'ha (Tamil Chitram) when the Sun enters the Sign *Mesha* ♈. This holy day is kept by resorting to the sacred rivers, giving alms, and sacrificing to the Pitris, or spirits of deceased ancestors: also a day of recreation.

2. *Dechanayan'a Punia Calum*.—The 1st day of the month *Sra'vana* (Tamil *Audi)* when the Sun enters *Carcata* ♋. The same observances as for *Vaisác'ha*.

3. *Audy Pundaga*.—The last day of the same month, a day of recreation and entertainment; on which the Hindus feast on boiled cocoanuts.

4. *Vishu Punia Calum*.—The 1st day of the month Cártiga (Tamil *Arpesi)* when the Sun enters the Sign *Tula* ♎: the same observances as for Vaisác'ha.

5. *Uttarayana Punia Calum*.—The 1st day of the Solar month Magh (Tamil *Tye)* when the Sun enters the Sign *Carcata* ♑. This is the grand festival of the Pungol, on which day, after the usual bathings, giving of alms, and sacrifices to the Pĭtris, the Hindus offer boiled rice to the Sun, then scatter it over their fields to propitiate abundance. At the end of the ceremonies, they worship the Cow, and then it is pretended that some ill luck falls on a particular *animal* which becomes a victim for the general safety.

Matoo Pungol.—This is a continuation of the feast which began on the preceding day. The worship of the Cows and Bulls continues: all the cattle are decked with flowers, painted horns, &c. and driven about the fields, as if for their amusement.

N. B. For the anniversaries of the accession of the 14 Menus, see Text, page 311.

⁂

ERRATA.

PREFACE.

Page. Line.
iii 4 from the top, for *Jyantish*, read *Jyótish.* The same correction in the 3d line from the bottom.
vii 11 from the top, strike off the full stop . and read ;
ix 2 from the bottom, for *Cycles*, read *Cycle.*
xii 13 from the bottom, for *Phænomenæ*, read Phœnomena.
ib. in the same line, for $2^h\ 24^m$, read $8^h\ 58^m$ or $22^g\ 25^v\ 36^p$ Hindu time.

FIRST MEMOIR.

11 last word of the page, for *Ascendentia*, read *Antecedentia.*
17 15 from the top, for *at the end of the Tables*, read *in Appendix* iv, *page* 307.
20 1 of the note, for *Note*, read *Appendix* ii, *page* 245.
23 5 from the bottom, for *Cycle*, read *Style.*
ib. last line of all, for Cali-yugam 3102, read 903-2.
26 7 from the bottom, for *Ascendentia*, read *Antecedentia.*
29 13 from the bottom, for *could*, read *would.*
36 23 from the top, for *Ascendentia*, read *Antecedentia.*
39 11 from the bottom, for *let it be*, read *let be.*
40 16 from the bottom, for Chronologists, read Chronologers.
43 8 from the bottom, for *at*, read *with.*
45 1 of the note, for *Note*, read Second Appendix, page 307.
54 14 from the top, strike off the comma between "*less than*, and *for*; and place it after *Rest.*
ib. 17 from the top, for *is*, read *was.*

SECOND MEMOIR.

69 last figure in the Table at the bottom, for 25, read 24.
ib. 7 from the top, for *Malkya*, read *Muc'hya.*
70 7 from the top, for Sanyama, read *Sangama.*
71 7 in the note, for *Narikas*, read *Nazicays.*
ib. last line of the note, for "*at the end of the Tables*", read *of the Volume.*
73 12 from the bottom, for "*Third Memoir*", read Appendix to the Second Memoir, page 169.
75 14 from the top, for *Bhaiava*, read *Bhalava.*
ib. 8 from the bottom, for *lasts*, read *is.*
ib. last line of all, for *third Memoir*, read *Appendix to the Second Memoir.*
76 16 from the top, strike off the stop after *Mahayug)* and of the following word strike off T, and read *the.*
77 11 from the top, for *Keta*, read *Ketu.*
81 12 from the bottom, for *Memoirs*, read *Memoir.*
86 8 of the note, for *Notation*, read *Nutation.*
ib. last line but one of the note, for *Epycicular*, read *Epicircular.*
87 2 at top, for "*and the Amavasya*", read *and the ends of the Amavasya, and Prathama Tithis.*
90 14 from the top, insert 45^g over the quantity $28^g\ 45^v\ 32^p$ and read thus

$$\begin{array}{rrr} 45^g & & \\ -\ 28 & 45 & 32 \\ \hline 16 & 14 & 23 \end{array}$$

Page. Line.
94 7 from the top, for "*let it be*," read *let be*.
103 last line of all, the same correction.
104 last note, for Booja, read *Bhuja*.
115 4 of the article C, after "the Sun and Moon's," add *relative* (revolutions).
117 1 in the note, strike off *Amavasya*.
124 in the marginal note, for *Moon*, read *Sun*.
127 9 from the top, for *Equation*, read Motion.
130 4 from the bottom, for *Malasyan*, read Malayala.
142 3 from the top, strike off I.
153 8 of Article 2, for *these*, read *those*.
158 last line but one, for "*the time that will elapsed*", read the time that will *have* elapsed.

APPENDIX TO THE SECOND MEMOIR.

171 4 from the top, for *Josela Barcajosey*, read *Joscla Basçarjosey*.

THIRD MEMOIR.

197 13 from the top, for *precedes*, read *precede*.
ib. 15 from the top, for *those of the two*, read one of the two.
ib. 4 from the bottom, for *inspection*, read *analogy*.
199 10 from the top, at the beginning, strike off 24^s.
200 7 from the top, for "*will be*," read *was*.
201 2 from the top, for $353^d\ 17^g\ 10^v\ 31^p$, read $353^d\ 27^g\ 10^v\ 31^p$.
204 1 of the note, for *Suda*, read *Sucla*.
215 13 from the bottom, after *of the Cali-yug*, add *be proposed*.

FOURTH MEMOIR.

220 in the note, for page 22 infra, read page 232.

APPENDIX II.

246 13 from the top, for *Chronologist*, read *Chronologer*.
247 3 from the top, for *invention*, read *inventor*.
255 3 from the bottom, in the sum of the Sun's mean Longitude, for $0^s\ 38^\circ\ 0'\ 52{,}9$, read $0^s\ 18^\circ\ 0'\ 52{,}9$.
267 5 of proposition C, from the equation at the end, strike off = the sign of equality, and substitute ∽ that of ratio.
274 in the note, last line of figures, for $T = \underline{26^d\ 8^g\ (56}$, read $\underline{26^d\ 8^g\ 0^v\ 56^p}$.
ib. last line of the note, after "which is the same as above", add "vide page 273."
279 in the computation of the Sun's apparent Longitude, at the bottom, wherever the word *Notation* appears, read *Nutation*.

APPENDIX III.

297 1 at the top, at its beginning, for "the *last* of which is always of 355 days, read "*Eleven* of which are always of 355 days."
ib. wherever the words *Yerdegird*, and *Yerdegirdic* appears in this page, read *Yezdegird* and *Yezdegirdic*.
ib. 18 from the top, for *revolutions*, read *account*.
298 4 from the bottom, for Chronologist, read Chronologer.
299 7 from the top, for *Murshervam*, read *Marshesvam*.
302 8 from the top, for *Snidas*, read *Suidas*.
304 6 from the bottom, for "*il freit*", read *il fait*.
ib. 5 from the bottom, for *Pau*, read *Pan*.

APPENDIX IV.

Page Line.

307 3 of the first paragraph, for "*amount to six hours of time*", read "*amount to nearly* NINE *hours of time.*"

309 14 from the top, at the end, for "*before* A", read *behind* A.

318 in the heading of the second column of the Kalendar, for "or *Chaitram*", read "or Bengal *Chaitra.*"

FRAGMENT I.

325 1 of the third paragraph, for *combats*, read *combates.*

ib. 8 from the bottom, at the end, for "it proceeds $3^{s}\,\frac{1}{4}$ to $3^{s}\,\frac{3}{4}$", read "it proceeds *from* $3^{s}\,\frac{3}{4}$ to $3^{s}\,\frac{1}{4}$."

329 3 from the top, near the end, for "it is constructed", read "it was constructed."

FRAGMENT IV.

336 2 & 3 of Article I, to "4926, of the Cali yug, and the 1747th since the birth of Sali. "vahana", add "*elapsed;* the current years being 4927th of the Cali yug, and "1748th Saca."

339 4 from the top, for the *Sun's* mean motion, read the *Moon's* mean motion.

347 In the line of *Digits*, for $12'\,30''$, read $12^{\circ}\,30'$, and the same of the two other quantities.

ASTRONOMICAL TABLES.

2 Table II, in the last line of the last paragraph, for *notation*, read *account.*

19 Table XVII, 1st and 2d line of the title, for *corresponding*, read *relatively.*

31 Table XXVI, for the word *Druva* inserted in the headings of the second columns of the Table, read *P'hala.*

33 Table XXVII, Part 1, in the second line after the Table, for "*origin Chaitram,*" read "origin of Chaitram."

ib. 7th line do. for "*of initial root*", read "of *the* initial root."

34 Table XXVII, Part 2, second line of the title. strike off *and.*

44 Table XXXIII, in the body of the Table, after *Benares*, the Hindu name *Cassi* of that city should be inserted; and for the same reason, after *Oogein*, should appear *Ujani.*

65 Table XLIX, last line of all, after the words "*civil reckoning*", add "the difference 21^{c} " 25^{v} 48^{p} (8^{h} $34'$ $19''$,2 E. T.) being only a fraction of the current day."

CHRONOLOGICAL TABLES.

Line.

v 15 from the top, for "address himself *to*", read *address himself.*

vii 18 from the bottom, for "on the 10th of April at 51^{c} 15^{v}", read "on the 10th April " *(and Column XI)* at 51^{c} 15^{v}."

ix 2 from the top, at the beginning, for "11th April," read "(according to Dr. Wilson's communication) 12th April."

xiii 15 from the top, for "*or* in the latter supposition", read "*but* in the latter supposition."

xx 4 from the top, for "as we find an *asterisk*", read "as we find a *B.*

N. B.—For the Errata in the spelling of the Sanscrit terms, see the Glossary.

⁂

ASTRONOMICAL TABLES

REFERRED TO IN THE

KALA SANKALITA.

TABLE I.

For finding the Initial Feria, and Sydereal beginning of any Solar Year, according to the Tamul Kalendar: the duration of the year (that of the Ariah Siddhanta) being 365d 15g 31v 15p.

Vachij.

	Cali yug. 4802	Roots.				To be used with an Epoch.				
		D.	G.	V.	P.	Secular years.	Roots.			
Druva.	Epoch or Druva. A. D. 1700	(6)	2	11	15					
	Roots 1	(1)	15	31	15	100	(6)	52	5	0
	2	(2)	31	2	30	200	(6)	44	10	0
	3	(3)	46	23	45	300	(6)	36	15	0
	4	(5)	2	5	0	400	(6)	28	20	0
	5	(6)	17	36	15	500	(6)	20	25	0
	6	(0)	33	7	30	600	(6)	12	30	0
	7	(1)	48	38	45	700	(6)	4	35	0
	8	(3)	4	10	0	800	(5)	56	40	0
	9	(4)	19	41	15	900	(5)	48	45	0
	10	(5)	35	12	30	1000	(5)	40	50	0
	20	(4)	10	25	0					
	30	(2)	45	37	30					
	40	(1)	20	50	0					
	50	(6)	56	2	30					
	60	(5)	31	15	0					
	70	(4)	6	27	30					
	80	(2)	41	40	0					
	90	(1)	16	52	30					
	100	(6)	52	5	0					

EXAMPLE.

For the year of the Cali yug 4847 current or A. D. 1745.

	D.	G.	V.	P.
Epoch for 1700	(6)	2	11	15
Root for 40 years	(1)	20	50	0
Do. for 4 years	(5)	2	5	0
Root	(5)	25	6	15

which Root (5) is to be counted from *Sunday*, i. e. *Friday, Sucra-vara.*

N. B.—If the beginning of the year 1700 be required—

	D.	G.	V.	P.
Subtract Root for 1 year from the Epoch	(6)	2	11	15
Root for 1 year	(1)	15	31	15
Beginning of Chaitram and year Cal. 4802	(4)	46	40	0

Thursday, Guru-vara.

TABLE II.

For finding the Initial Feria or Soota dina and Sydereal beginning of the Solar years of the Cycle of 90 *years, called* Grahaparivrithi, *as used in the Southern Provinces of the Peninsula, the year being of* 365^{d} 15^{g} 31^{v} 30^{p} *that of the* Vakia Carana.

Sittandij.

For the beginning of the year Cm. 4847 (1745.)

First Epoch or *Atchu* A Cali yug 3078 complete; or A. Ante Chris. 24.

Epochs of Cycles.		Roots of Years.	
Cycles.	Epochs.	Years.	Roots.
	D. G.		D. G.
0	(6) 4	0	(0) 0
1	(0) 19	1	(1) 19
2	(1) 36	2	(2) 31
3	(2) 53	3	(3) 47
4	(4) 10	4	(5) 2
5	(5) 27	5	(6) 18
6	(6) 44	6	(0) 33
7	(1) 1	7	(1) 49
8	(2) 18	8	(3) 4
9	(3) 35	9	(4) 20
10	(4) 52	10	(5) 35
11	(6) 9	20	(4) 10
12	(0) 26	30	(2) 45
13	(1) 43	40	(1) 21
14	(3) 0	50	(6) 56
15	(4) 17	60	(5) 31
16	(5) 34	70	(4) 6
17	(6) 51	80	(2) 42
18	(1) 8	90	(1) 17
19	(2) 25		
20	(3) 42		
21	(4) 59		
22	(6) 16		
23	(0) 33		
24	(1) 50		

EXAMPLE

of the Calculus, according to the Sittandij, for the year Cali yug 4847 current or A. D. 1745.

To determine the Cycle.

90)1744(19
34
add 24
58

Answer. 19th Cycle 58th year.

RULE.

	D.	G.	V.
Epoch Cycle 19	(2)	25	
Root for years 50	(6)	56	
Ditto for 8	(3)	4	
Epoch	(5)	25	0
which being an even year, add +		,,	31
Beginning of year & Chait.	(5)	25	31

From which it appears that the beginning of the year and Chaitram falls after the 5th day from Sunday, i. e. *Friday*, at 25^{g} 31^{v} after Sun rise, which fraction of day being less than 30 guddias, marks the time before Sun set (at Lanca), and in this case the Civil and Sydereal notation agree.

	D.	G.	V.	P.
According to the Vachij,	(5)	25	6	15
to the Sittandij	(5)	25	31	0
Difference	,,	,,	24	45

TABLE III.

Exhibiting the Tamul names of the Solar months; their absolute duration; their Roots; and the corresponding Signs of the Zodiac.

European months, Old Style.	I.							II.							III.							
	Time ascribed to each Sign.							Roots of Indian Months separately taken.							Roots of Indian Months collectively taken.							
	Types of Signs of the Hindu Zodiac.	Tamul Months corresponding with 12 Signs of the Zodiac.	The Longitude of the 1st of Mesha corresponding with 1st Chaitram to be taken 18° 41′ 26″ A. C. 4847 (1745.)				European Months, N. S.	Tamul months.	The Hindus assign 186d 21h 38′ 24″ of our Time for the Sun to move thro' the N. S. & 178d 8h 34′ 6″ the S. S.				Types of Signs of the Hindu Zodiac.	Types of Signs and corresponding months of the European Zodiac.	This division to be used for finding at once the beginning of months when that of the year has been found.				Names of the Hindu Signs of the Zodiac.	Names of the Hindu months of the Astronomical year.	European months, N. S.
			D.	G.	V.	P.			D.	G.	V.	P			D.	G.	V.	P.			
March	♈	Chaitram	30	55	32	1	April	Chaitram	(2)	55	32	1	♈	♉ April	(2)	55	32	1	Mésha	Vaisacha	April
April	♉	Viassei	31	24	12	1	May	Viassei	(3)	24	12	1	♉	♊ May	(6)	19	44	2	Vrĭsha	Jaish'ta	May
May	♊	Auni	31	36	38	1	June	Auni	(3)	36	38	1	♊	♋ June	(2)	56	22	3	Mid'huna	Ashar	June
June	♋	Audi	31	28	12	2	July	Audi	(3)	28	12	2	♋	♌ July	(6)	24	34	5	Carcáta	Sravana	July
July	♌	Auvani	31	2	10	1	August	Auvani	(3)	2	10	1	♌	♍ August	(2)	26	44	6	Sinha	Bha'dra	August
August	♍	Paratasi	30	27	22	1	Sept.	Paratasi	(2)	27	22	1	♍	♎ September	(4)	54	6	7	Canyà	Aswina	Sept.
Sept.	♎	Arpesi	29	54	7	1	Oct.	Arpesi	(1)	54	7	1	♎	♏ October	(6)	48	13	8	Tulà	Cartiga	Oct.
Oct.	♏	Cartiga	29	30	24	2	Nov.	Cartiga	(1)	30	24	2	♏	♐ November	(1)	18	37	10	Vrischica	Margasiras	Nov.
Nov	♐	Margali	29	20	53	1	Dec.	Margali	(1)	20	53	1	♐	♑ December	(2)	39	30	11	Dhanus	Paushya	Dec.
Dec.	♑	Tye	29	27	16	1	Jan.	Tye	(1)	27	16	1	♑	♒ January	(4)	6	46	12	Macara	Magh	Jan.
Jan.	♒	Maussi	29	48	24	1	Feb.	Maussi	(1)	48	24	1	♒	♓ February	(5)	55	10	13	Cumbha	Phalguna	Feb.
Feb.	♓	Poongoni	30	20	21	2	March	Poongoni	(2)	20	21	2	♓	♈ March	(1)	15	31	15	Min	Chitra	March.

Particular attention is to be paid to the European month which concurs with Chaitram, which in present times is April, N. S. but in Old Style is March.—In that case, taking out the Root to get the beginning of the 2d month in the year, instead of taking that for April (2) 55 32 1, which is the first in the column, you are to take the same as for March.

How to find the beginning of any month in the year, by means of Table I and III.

EXAMPLE.

Having found by the Rule given at the foot of Table I, the manner of determining the 1st of Chaitram and year, according to the Vachij; and the same Table II, according to the Sittandij, let the 1st of the Tamul month Paratasi (Indian September) be required.

RULE.

Vachij.	D.	G.	V.	P.	*Sittandij.*	D.	G.	V.	P.
Beginning of Chaitram and year	(5)	25	6	15	Annual Epoch	(5)	25	31	0
Root Table III, part 3d, for Auvani (*preceding month*) complete, N. S.	(2)	26	44	6	Root Table III, part 3d,	(2)	26	44	6
Beginning of Paratasi	(0)	51	50	21	Indian September *Sunday.*	(0)	52	15	6

But if we use the 2d part of Table III, instead of part 3d, we would have to begin from the month of Chaitram, and in order to reach the proposed Epoch to sum up successively the Roots for every month up to that of Paratasi.

EXAMPLE.	D.	G.	V.	P.	*New Style.*
Beginning of Chaitram and year 4847	(5)	25	6	15	April
Root for Chaitram, p. 2, -	(2)	55	32	1	for May
Beginning of Viassei, - -	(1)	20	38	16	May
Root for Viassei, - -	(3)	24	12	1	for June
Beginning of Auni, - -	(4)	44	50	17	June
Root for Auni, - -	(3)	36	38	1	for July
Beginning of Audi, - -	(1)	21	28	18	July
Root for Audi, - -	(3)	28	12	2	for August
Beginning of Auvani, - -	(4)	49	40	20	August
Root for Auvani, - -	(3)	2	10	1	for September
August.—Beginning of Paratasi, - -	(0)	51	50	21	September.

The same as before.

It need hardly be observed, that the beginning of the ensuing year may be obtained by going on adding the Roots as far as the month Poongoni.

TABLE IV.

For converting European hours, minutes and seconds, into Hindu guddias, viguddias, paras, suras; and vice versa.

European hours, minutes and seconds into Hindu Time.					
European Time.	Hindu Time.		European Time.	Hindu Time.	
H.	G.	V.	H.	DAYS.	G.
m. s.	v. p.	p. s.	m. s.	g. v.	v. p.
1	2	30	10	0	25
2	5	0	20	0	50
3	7	30	30	1	15
4	10	0	40	1	40
5	12	30	50	2	5
6	15	0	60	2	30
7	17	30			
8	20	0			
9	22	30			
10	25	0			

Hindu guddias, viguddias and paras into European Time.					
Hindu Time.	European Time.		Hindu Time.	European Time.	
G.	H.	M.	G.	H.	M.
v. p.	m. s.	s. ″	v. p.	m. s.	s. ″
1	0	24	10	4	0
2	0	48	20	8	0
3	1	12	30	12	0
4	1	36	40	16	0
5	2	0	50	20	0
6	2	24	60	24	0.
7	2	48			
8	3	12			
9	3	36			
10	4	0			

The use of this Table is familiar to all Mathematicians. I shall, however, give two Examples of its application.

Example I.

To convert 15h 21m 35s into Hindu Time.

	G.	V.	P.	S.
Part 1st, 10h=	25			
5h=	12	30		
20m=		50		
1m=		2	30	
30s=		1	15	
5s=			12.	30
Answer -	38	23	57	30

Example II.

To convert 56g 37v 23p into European Time.

	H.	M.	S.	″
Part 2d, 50g=	20			
6g=	2	24		
30v=		12		
7v=		2	48	
20p=			8	
3p=			1	12
Auswer -	22	38	57	12

TABLE V.

For finding the Dominical Letter, Julian and Gregorian accounts.

PARTS FIRST AND SECOND.

Part 1st, Julian Secular years.										Part 2d, Gregorian Secular years.		
1	2	3	4	5	1	2	3	4	5	1	2	3
Years of Æra Cali yug current.	Concurrent Christian Secular years O. S.	Days of the week beginning each Christian century Julian Style.	Dominical Letter O. S.	Beginning of concurrent year Cali yug O.S.	Year of Æra Cali yug current.	Concurrent Christian years O. S.	Days of the week beginning each Christian century Julian Style.	Dominical Letter O. S.	Beginning of concurrent year Cali yug O S	Days of the week beginning each Christian century Gregorian Style.	Dominical Letter N. S.	Beginning of concurrent year Cali yug N.S.
	A. D.			March.		A. D.			March			
3102	0	Thursday	DC	14	4202	1100	Sunday	AG	23			
3202	100	Wednes	ED	14	4302	1200	Saturday	BA	24			
3302	200	Tuesday	FE	15	4402	1300	Friday	CB	25			
3402	300	Monday	GF	16	4502	1400	Thursday	DC	26			April.
3502	400	Sunday	AG	17	4602	1500	Wednes	ED	27	Monday	G	5
3602	500	Saturday	BA	18	4702	1600	Tuesday	FE	27	Saturday	BA	6
3702	600	Friday	CB	19	4802	1700	Monday	GF	28	Friday	C	8
3802	700	Thursday	DC	20	4902	1800	Sunday	AG	29	Wednes	E	10
3902	800	Wednes	ED	20	5002	1900	Saturday	BA	30	Monday	G	12
4002	900	Tuesday	FE	21	5102	2000	Friday	CB	31	Saturday	BA	13
4102	1000	Monday	GF	22								

HEADS OF THE COLUMNS.

Part First.

1. Tamul Solar years counted from Epoch Cali yugam current.
2. Christian Secular Julian years concurrent with the same.
3. Days of the week beginning each Christian century according to the *Julian* Kalendar.
4. Dominical Letters of Christian Secular years O. S.
5. Date on which the concurrent Tamul year begins according to the *Julian* Kalendar.

Part Second.

1. Days of the week on which the Christian century begins according to the *Gregorian* Kalendar.
2. Dominical Letters of Christian Secular years N. S.
3. Date on which the concurrent Tamul year begins according to the *Gregorian* Kalendar.

TABLE V.

PART THE THIRD.

Julian Secular years.					
1	2	3	4	5	6
Anno Ante Christian Æra.	Anno Mundi.	Anno from the Epoch Cali yugam. + —	Dominical Letter O.S.	Day of the week beginning each Christian century Julian Style.	Day of the month on which the Hindu year begins.
		Ante Cali yug.			February
4004	1 (*)	—903.2	DC	Thursday	8
4000	4	—898.7	FE	Tuesday	8
		Post Cali yug.			
3000	1004	+ 102	BA	Saturday	16
2000	2004	1102	ED	Wednesday	25
					March
1000	3004	2102	AG	Sunday	5
900	3104	2202	BA	Saturday	6
800	3204	2302	CB	Friday	7
700	3304	2402	DC	Thursday	7
600	3404	2502	ED	Wednesday	8
500	3504	2602	FE	Tuesday	9
400	3604	2702	GF	Monday	10
300	3704	2802	AG	Sunday	11
200	3804	2902	BA	Saturday	12
100	3904	3002	CB	Friday	13
0	4004	3102	DC	Thursday	14

SUPPLEMENT.

Julian Secular years from A. A. C. 1000.	Dominical Letter O. S.	Julian Secular years from A. A. C. 1000.	Dominical Letter O. S.	Julian Secular years from A. A. C. 1000	Dominical Letter O. S	Julian Secular years from A. A. C. 1000.	Dominical Letter O. S.
4000	FE	3100	AG	2200	CB	1300	ED
3900	GF	3000	BA	2100	DC	1200	FE
3800	AG	2900	CB	2000	ED	1100	GF
3700	BA	2800	DC	1900	FE	1000	AG
3600	CB	2700	ED	1800	GF		
3500	DC	2600	FE	1700	AG		
3400	ED	2500	GF	1600	BA		
3300	FE	2400	AG	1500	CB		
3200	GF	2300	BA	1400	DC		

(*) Fort Royal account.

TABLE VI.

For finding the feria or weekly day which begins any proposed year.

This Table is always to be entered with the odd Christian year *current* of the Century.

Part 1st, Julian Style.

Number of days to be added to the day of the week beginning the Century for finding the 1st weekly day in the given year.

0	1	2	3	4	5	6
Odd years of Centuries.						
*	0	1	2	3	4	10
5	6	7	8	14	9	16
11	12	18	13	20	15	21
22	17	24	19	25	26	27
28	23	29	30	31	32	38
33	34	35	35	42	37	44
39	40	46	41	48	43	49
50	45	52	47	53	54	55
56	51	57	58	59	60	66
61	62	63	64	70	65	72
67	68	74	69	76	71	77
78	73	80	75	81	82	83
84	79	85	86	87	88	94
89	90	91	92	98	93	100
95	96		97		99	

Part 2d, Gregorian Style.

Number of days to be added to the day of the week beginning the Century for finding the 1st weekly day in the proposed year.

0	1	2	3	4	5	6
Odd years of Centuries.						
0	1	2	3	4	10	5
6	7	8	14	9	16	11
12	18	13	20	15	21	22
17	24	19	25	26	27	28
23	29	30	31	32	38	33
34	35	36	42	37	41	39
40	46	41	48	43	49	50
45	52	47	53	54	55	56
51	57	58	59	60	66	61
62	63	64	70	65	72	67
68	74	69	76	71	77	78
73	80	75	81	82	83	84
79	85	86	87	88	94	89
90	91	92	98	93	100	95
96		97		99		

The construction and use of this Table are explained in the *first Memoir*. *It is in all cases to be entered with the proposed current odd year of the Century.*

For the years before Christ either Part first or second is to be used, as the given year happens to be a bissextile or a common one; a distinction, however, which does not apply to years after Christ.

TABLE VII.

Shewing the Epochs and Roots of Secular years from A. D. 0 *to* 2000.

The construction and use of this Table are explained in the first Memoir. The manner of using it is the same as that indicated at the foot of Table I, where the Epoch for 1700, marked at the top of the 1st column (6ᵈ) 2ᵍ 11ᵛ 15ᵖ, is taken for the resolution of the beginning of A. Cm. 4847 (1745).

The 3d column exhibits the proper Roots of the Secular years which indicates at once its beginnings without the subtraction of one year from the Epoch for the same year, which is apt to occasion mistakes.

The Roots for the odd years are to be taken out of Table I.

1		2	3	
European Secular years.	Concurrent years Cali yugam commencing.	Epochs marking the beginning of the same Hindu year.	Roots of the same differing from Epochs by 1 Hindu year.	Julian date in March.
		D. G. V. P.	D. G. V.	
0	3102	(1) 16 46 15	(0) 1 15	14
100	3202	(1) 8 51 15	(6) 53 20	14
200	3302	(1) 0 56 15	(6) 45 25	15
300	3402	(0) 53 1 15	(6) 37 30	16
400	3502	(0) 45 6 15	(6) 29 35	17
500	3602	(0) 37 11 15	(6) 21 40	18
600	3702	(0) 29 16 15	(6) 13 45	19
700	3802	(0) 21 21 15	(6) 5 50	20
800	3902	(0) 13 26 15	(5) 57 55	20
900	4002	(0) 5 31 15	(5) 50 0	21
1000	4102	(6) 57 36 15	(5) 42 5	22
1100	4202	(6) 49 41 15	(5) 34 10	23
1200	4302	(6) 41 46 15	(5) 26 15	24
1300	4402	(6) 33 51 15	(5) 18 20	25
1400	4502	(6) 25 56 15	(5) 10 25	26
1500	4602	(6) 18 1 15	(5) 2 30	27
1600	4702	(6) 10 6 15	(4) 54 35	27
1700	4802	(6) 2 11 15	(4) 46 40	28
1800	4902	(5) 54 16 15	(4) 38 45	29
1900	5002	(5) 46 21 15	(4) 30 50	30
2000	5102	(5) 38 26 15	(4) 22 55	31

EXAMPLE.

Wanted the beginning of A. D. 622, or Cali yugam 3721 (545 Saca).

		D.	G.	V.	P.
By Table VII, 1st and 2d Part, Epoch for A. D. 600		(0)	29	16	15
Root for 20 years, by Table I.		(4)	10	25	0
Do. for 1 year complete Do.		(1)	15	31	15
Beginning of Chaitram and year 3724 Cali yugam or 545 Saca	*Friday*	(5)	55	12	30
	Sucra-vara.				

The (6) in the 3d column shews at once that the Secular year 3702 Cali yugam (A. D. 600) began on a *Saturday*, *Sani-vara*, answering to the 19th March, O. S. both Civil and Sydereal accounts.

TABLE VIII.

PART FIRST.

For years ascending from the birth of Christ, from 0 to 100.

Years of the First Century B. C. ascending.						
Years Ante Christ. Æra.	Anno Mundi. (*)	Anno Cali yugam.	Roots indicating the beginning of each Tamul year.			
			D.	G.	V.	P.
100	3904	3002	(0)	9	10	0
90	3914	3012	(5)	44	22	30
80	3924	3022	(4)	19	35	0
70	3934	3032	(2)	54	45	30
60	3944	3042	(1)	30	0	0
50	3954	3052	(0)	5	12	30
40	3964	3062	(5)	40	20	0
30	3974	3072	(4)	15	37	30
20	3984	3082	(2)	50	50	0
10	3994	3092	(1)	26	2	30
9	3995	3093	(2)	41	33	45
8	3996	3094	(3)	57	5	0
7	3997	3095	(5)	12	36	15
6	3998	3096	(6)	28	7	30
5	3999	3097	(0)	43	38	45
4	4000	3098	(1)	59	10	0
3	4001	3099	(3)	14	41	15
2	4002	3100	(4)	30	12	30
1	4003	3101	(5)	45	43	45
0	4004	3102	(0)	1	15	0

The construction and use of this Table are explained in the first Memoir.

Of this Table it is to be observed, that it gives the absolute Root for the beginning of years. That is to say, no Epoch is to be added to the quantity registered, in order to obtain the Sydereal beginning of Chaitram and year falling within its limits.

If the beginning of a year from 10 to 100 B. C. be required, take the Root of the nearest one, and complete it with the Root of the intermediate years out of Table I.

EXAMPLE.

Let the Root for the beginning of the 24th year before Christ be required.

		D.	G.	V.	P.	
Take Root for 20 years, Table VIII	-	(2)	50	50	0	
Do. for 4 *years*, Table I	—	(5)	2	5	0	
Beginning of A. Cm. 3078 (B. C. 24) Thursday		(4)	48	45	0	
The same by the Epoch. A. D. 0 Ep.	-	(1)	16	46	15	Table VIII, part 2,
For 20 years, Table I - - -	—	(4)	10	25	0	
		(4)	6	21	15	
Do. for 5 *years* Do. - - -	—	(6)	17	36	15	
Beginning of Chaitram and year	-	(4)	48	45	0	the same as before

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(*) Port Royal account.

TABLE VIII.

PART THE SECOND.

For years ascending from the birth of Christ 0, *to that of the Creation, according to the Mosaic system.*

Years ascending to the Creation.					
Anno Ante Christian Æra.	Anno Mundi.	Concurrent years Cali yugam.	Epochs of Secular years.	Roots of Secular years.	Beging of Solar years, Julian.
(*) Origin of Time at Noon, Sunday.				D. G. V. P. (0) 15 50 0	Feby. 8
			D. G. V. P.		
4004	1	—903. 2	(2) 46 52 30	(1) 31 21 15	8
4000	4	—898. 7	(6) 33 26 15	(5) 17 55 0	8
3000	1004	102	(5) 14 16 15	(3) 58 45 0	16
2000	2004	1102	(3) 55 6 15	(2) 39 35 0	25
					March
1000	3004	2102	(1) 35 56 15	(1) 20 25 0	5
900	3104	2202	(2) 28 1 15	(1) 12 30 0	6
800	3204	2302	(2) 20 6 15	(1) 4 35 0	7
700	3304	2402	(2) 12 11 15	(0) 56 40 0	7
600	3404	2502	(2) 4 16 15	(0) 48 45 0	8
500	3504	2602	(1) 56 21 15	(0) 40 50 0	9
400	3604	2702	(1) 48 26 15	(0) 32 55 0	10
300	3704	2802	(1) 40 31 15	(0) 25 0 0	11
200	3804	2902	(1) 32 36 15	(0) 17 5 0	12
100	3904	3002	(1) 24 41 15	(0) 9 10 0	13
0	4004	3102	(1) 16 46 15	(0) 1 15 0	14

The construction and use of this Table are explained in the last Section of Part 1st of the first Memoir. Its application differs in nothing from that of Table VII, excepting that if the Epochs are used for expounding the beginnings of the Hindu years, *one* year is to be *added* instead of *subtracted* (for having the complete Solar year *ending*) to the notation of the proposed year; because the years before Christ are noted *increasing* whilst *ascending*, as is exemplified in the Rule at the foot of the preceding page.

(*) It may be worth noticing, that in calculating the beginning of the Solar Sydereal year of the Creation according to the Mosaic system, by the Hindu formula, it falls on a *Sunday*, 8th February, very near noon, the difference being only 20 minutes European time.

TABLE IX.

Exhibiting the Dominical Letter for every day in the year.

January.		February.		March.		April.		May.		June.		July.		August.		September		October.		November		December	
1	A	1	d	1	d	1	g	1	b	1	e	1	g	1	c	1	f	1	A	1	d	1	f
2	b	2	e	2	e	2	A	2	c	2	f	2	A	2	d	2	g	2	b	2	e	2	g
3	c	3	f	3	f	3	b	3	d	3	g	3	b	3	e	3	A	3	c	3	f	3	A
4	d	4	g	4	g	4	c	4	e	4	A	4	c	4	f	4	b	4	d	4	g	4	b
5	e	5	A	5	A	5	d	5	f	5	b	5	d	5	g	5	c	5	e	5	A	5	c
6	f	6	b	6	b	6	e	6	g	6	c	6	e	6	A	6	d	6	f	6	b	6	d
7	g	7	c	7	c	7	f	7	A	7	d	7	f	7	b	7	e	7	g	7	c	7	e
8	A	8	d	8	d	8	g	8	b	8	e	8	g	8	c	8	f	8	A	8	d	8	f
9	b	9	e	9	e	9	A	9	c	9	f	9	A	9	d	9	g	9	b	9	e	9	g
10	c	10	f	10	f	10	b	10	d	10	g	10	b	10	e	10	A	10	c	10	f	10	A
11	d	11	g	11	g	11	c	11	e	11	A	11	c	11	f	11	b	11	d	11	g	11	b
12	e	12	A	12	A	12	d	12	f	12	b	12	d	12	g	12	c	12	e	12	A	12	c
13	f	13	b	13	b	13	e	13	g	13	c	13	e	13	A	13	d	13	f	13	b	13	d
14	g	14	c	14	c	14	f	14	A	14	d	14	f	14	b	14	e	14	g	14	c	14	e
15	A	15	d	15	d	15	g	15	b	15	e	15	g	15	c	15	f	15	A	15	d	15	f
16	b	16	e	16	e	16	A	16	c	16	f	16	A	16	d	16	g	16	b	16	e	16	g
17	c	17	f	17	f	17	b	17	d	17	g	17	b	17	e	17	A	17	c	17	f	17	A
18	d	18	g	18	g	18	c	18	e	18	A	18	c	18	f	18	b	18	d	18	g	18	b
19	e	19	A	19	A	19	d	19	f	19	b	19	d	19	g	19	c	19	e	19	A	19	c
20	f	20	b	20	b	20	e	20	g	20	c	20	e	20	A	20	d	20	f	20	b	20	d
21	g	21	c	21	c	21	f	21	A	21	d	21	f	21	b	21	e	21	g	21	c	21	e
22	A	22	d	22	d	22	g	22	b	22	e	22	g	22	c	22	f	22	A	22	d	22	f
23	b	23	e	23	e	23	A	23	c	23	f	23	A	23	d	23	g	23	b	23	e	23	g
24	c	24	f	24	f	24	b	24	d	24	g	24	b	24	e	24	A	24	c	24	f	24	A
25	d	25	g	25	g	25	c	25	e	25	A	25	c	25	f	25	b	25	d	25	g	25	b
26	e	26	A	26	A	26	d	26	f	26	b	26	d	26	g	26	c	26	e	26	A	26	c
27	f	27	b	27	b	27	e	27	g	27	c	27	e	27	A	27	d	27	f	27	b	27	d
28	g	28	c	28	c	28	f	28	A	28	d	28	f	28	b	28	e	28	g	28	c	28	e
29	A			29	d	29	g	29	b	29	e	29	g	29	c	29	f	29	A	29	d	29	f
30	b			30	e	30	A	30	c	30	f	30	A	30	d	30	g	30	b	30	e	30	g
31	c			31	f			31	d			31	b	31	e			31	c			31	A

TABLE X.

Table shewing some of the forms assumed by the mouths of the mean Solar Tamul year, with reference to the Gregorian Style.

The twelve months of the year Cali yug 4847 (A. D. 1745-6).					The twelve months of the year Cali yog 4856 (1754-5).					The twelve months of the year Cali yug 4915 (1813-14).				
Names of Tamul months.	Roots of beginnings of months, with fractions.	Days of the week commencing months.	Concurrent Christian date.	Number of days in each month.		Roots of beginnings of months, with fractions.	Days of the week commencing months.	Concurrent Christian date.	Number of days in each month.		Roots of beginings of months, with fractions.	Days of the week commencing months.	Concurrent Christian date.	Number of days in each month.
1745	D. G. V. P.	C	1745			D. G. V. P.					D. G. V. P.			
Chaitram	(5) 25 6 15	Friday	9 April	31	1754	(2) 44 47 30	Tues	9 April	31	1813	(0) 0 31 15	Sunday	11 April	30
Vyassei	(1) 20 38 16	Mon	10 May	31	Dom.	(5) 40 19 31	Friday	10 May	32	D.L.	(2) 56 3 16	Tues	11 May	32
Auni	(4) 44 50 17	Thurs	10 June	32	letter	(2) 4 31 32	Tues	11 June	31	C	(6) 20 15 17	Satur	12 June	31
Audl	(1) 21 28 18	Mon	12 July	31	F	(5) 41 9 33	Friday	12 July	32		(2) 56 53 18	Tues	13 July	32
Auvani	(4) 49 40 20	Thurs	12 Aug	31		(2) 9 21 35	Tues	13 Aug	31		(6) 25 5 20	Satur	14 Aug	31
Paratasi	(0) 51 50 21	Sunday	12 Sept	31		(5) 11 31 36	Friday	13 Sept	30		(2) 27 15 21	Tues	14 Sept	30
Arpesi	(3) 19 12 22	Wed	13 Oct	30		(0) 38 53 37	Sunday	13 Oct	30		(4) 54 57 22	Thurs	14 Oct	30
Cartiga	(5) 13 19 23	Friday	12 Nov	29		(2) 33 0 38	Tues	12 Nov	30		(6) 48 44 23	Satur	13 Nov	30
Margali	(6) 43 43 25	Satur	11 Dec	30		(4) 3 24 40	Thurs	12 Dec	29		(1) 19 6 25	Mon	13 Dec	29
1746		B	1746		E					B				
Tye	(1) 4 36 26	Mon	10 Jan	29	1755	(5) 24 17 41	Friday	10 Jan	29	1814	(2) 40 1 26	Tues	11 Jan	30
Maussi	(2) 31 52 27	Tues	8 Feb	30		(6) 51 33 42	Satur	8 Feb	30		(4) 7 17 27	Thurs	10 Feb	29
Poongoni	(4) 20 16 28	Thurs	10 Mar	30		(1) 39 57 43	Mon	10 Mar	31		(5) 55 41 28	Friday	11 Mar	31
4848														
Chaitram	(6) 40 37 30	Satur	9 April			(4) 0 18 45	Thurs	10 April			(1) 16 2 30	Mon	11 April	
	Common 365 days							Leap 366 days					Common 365 d.	

TABLE X, *continued.*

Forms of Tamul years assumed with reference to the Julian Stylē.

The twelve months of the year Cali yug 4847. (*)					The twelve months of the year Cali yug 3903.				
Names of Tamul months.	Roots of beginnings of months, with fractions.	Days of the week commencing months.	Concurrent Christian date.	Number of days in each month.		Roots of beginnings of months, with fractions.	Days of the week commencing months.	Concurrent Christian date.	Number of days in each month.
1745	D. L. F				A.D.				
Chaitram	(2) 25 6 15	Friday	29 Mar	31	801	(0) 13 26 15	Sunday	21 Mar	31
Vyassei	(1) 20 38 16	Monday	29 April	31	D. L	(3) 8 58 16	Wed	21 April	31
Auni	(4) 44 50 17	Thursday	30 May	32	C	(6) 33 10 17	Satur	22 May	32
Audi	(1) 21 28 18	Monday	(*) 1 July	31		(3) 9 48 18	Wed	23 June	31
Auvani	(4) 49 40 20	Thursday	1 Aug	31		(6) 38 0 20	Satur	24 July	31
Paratasi	(0) 51 50 21	Sunday	1 Sept	31		(2) 40 10 21	Tuesday	24 Aug	31
Arpesi	(3) 19 12 22	Wednes	2 Oct	30		(5) 7 32 22	Friday	24 Sept	30
Cartiga	(5) 13 19 23	Friday	1 Nov	29		(0) 1 39 23	Sunday	24 Oct	29
Margali	(6) 43 43 25	Saturday	30 Nov	30		(1) 32 3 25	Monday	22 Nov	29
Tye	(1) 4 36 26	Monday	30 Dec	29		(2) 52 56 26	Tuesday	21 Dec	30
1746	D. L. E				802				
Maussi	(2) 31 52 27	Tuesday	28 Jan	30	B	(4) 20 12 27	Thursday	20 Jan	30
Poongoni	(4) 26 16 28	Thursday	27 Feb	30		(6) 8 36 28	Satur	19 Feb	30
Chaitram	(6) 40 37 30	Saturday	29 Mar			(1) 28 57 30	Monday	21 Mar	
				365					365

(*) It is to be remarked, in the construction of the year Cali yug 4847, concurrent with our A. D. 1745-6, that no *Hindu month* begins in our June (Julian Kalendar), and that the beginning of both *Cartiga* and *Margali* fall in our November, a circumstance which, if unattended to, might perplex a great deal the computer, and throw much confusion in the operation for converting dates from one Style into the other.

TABLES OF JUPITER.

Tables, for computing the rank, name, and beginning of the years of the Cycle of 60 *or Vrihaspati, computed relatively to the commencement of the concurrent Solar Sydereal year, according to the precept of the* Surriah *Siddhanta and Commentary.*

TABLE XI.

Jupiter's mean heliocentric motion for Solar years uncorrected, according to the Surriah Siddhanta.

I					II					III				
Years.	♃'s mean motion.				Years.	♃'s mean motion.				Years.	♃'s mean motion.			
	Signs	°	′	″		Rev.	S.	°	′		Rev.	S.	°	′
1	1	0	21	6	10	0	10	3	31	100	8	5	5	10
2	2	0	42	12	20	1	8	7	2	200	16	10	10	20
3	3	1	3	18	30	2	6	10	33	300	25	3	15	30
4	4	1	24	24	40	3	4	14	4	400	33	8	20	40
5	5	1	45	30	50	4	2	17	35	500	42	1	25	50
6	6	2	6	36	60	5	0	21	6	600	50	7	1	0
7	7	2	27	42	70	5	10	24	37	700	59	0	6	10
8	8	2	48	48	80	6	8	28	8	800	67	5	11	20
9	9	3	9	54	90	7	7	1	39	900	75	10	16	30
10	10	3	31	0	100	8	5	5	10	1000	84	3	21	40
										2000	168	7	13	20
										3000	252	11.	5	0
										4000	337	2	26	40
										5000	421	6	18	20

R. S. ° ′ ″
Druva A. Caliyugam complete 4400 - 370 11 17 20 0.

TABLE XII.

Annual Increment, or Equation of ♃'s mean heliocentric Longitude, according to the Tika, at the rate of 8 *Revolutions in a Maha yug, as used in present times.*

I			II			III		
Years.	Increment.		Years.	Increment.		Years.	Increment.	
	″	‴		′	″			
1	2	24	10	0	24	100	,,	4′
2	4	48	20	0	48	200	,,	8
3	7	12	30	1	12	300	,,	12
4	9	36	40	1	36	400	,,	16
5	12	0	50	2	0	500	,,	20
6	14	24	60	2	24	600	,,	24
7	16	48	70	2	48	700	,,	28
8	19	12	80	3	12	800	,,	32
9	21	36	90	3	36	900	,,	36
10	24	0	100	4	0	1000	,,	40
						2000	1°	20
						3000	2	0
						4000	2	40
						5000	3	20

Druva A. Cal. complete 4400 - 2° 56′ 0″.

TABLE XIII.

For converting Jupiter's mean heliocentric motion corrected into mean Solar Sydereal time; the year being 365^{D} 15^{d} 31^{p} [illegible] least.

I					II					III				IV		
°	Days.	Dandas.	Palas.	Castacalas.	′	Days.	Dandas.	Palas.	Castacalas.	″	Dandas.	Palas.	Castacalas.	‴	Palas.	Castacalas.
1	12	2	4	9,4744	1	0	12	2	4,1579	1	0	12	2,0693	1	0	12,0344
2	24	4	8	18,9489	2	0	24	4	8,3159	2	0	24	4.1386	2	0	24,0690
3	36	6	12	28,4232	3	0	36	6	12,4373	3	0	36	6,2079	3	0	36,1034
4	48	8	16	37,8977	4	0	48	8	16,6316	4	0	48	8,2772	4	0	48,1380
5	60	10	20	47,3722	5	1	0	10	20,7895	5	1	0	10,3465	5	1	0,1724
6	72	12	24	56,8466	6	1	12	12	24,9474	6	1	12	12,4157	6	1	12,2070
7	84	14	29	6,3210	7	1	24	14	29,1053	7	1	24	14,4850	7	1	24,2114
8	96	16	33	15,7954	8	1	36	16	33,2633	8	1	36	16,5543	8	1	36,2758
9	108	18	37	25,2699	9	1	48	18	37,4212	9	1	48	18,6236	9	1	48,3103
10	120	20	41	34,7443	10	2	0	20	41,5791	10	2	0	20,6929	10	2	0,3448
20	240	41	23	9,4886	20	4	0	41	23,1581	20	4	0	41,3859	20	4	0,6897
30	361	2	4	44,2329	30	6	1	2	4,7372	30	6	1	2,0789	30	6	1,0346
					40	8	1	22	46,3163	40	8	1	22,7719	40	8	1,3795
					50	10	1	43	27,8954	50	10	1	43,4649	50	10	1,7244
					60	12	2	4	9,4744	60	12	2	4,1579	60	12	2,0692

TABLE XIV.

For converting the fraction of the first term of the Jyautistava Rule into Saura *time, the Solar year being of 360 days,* $\frac{1875}{1875}$ *expressing such a* Saura *year.*

I				II				III		
Numerators	Days.	Dandas.	Palas.	Numerators	Days.	Dandas.	Palas.	Numerators	Days.	Dandas.
1	0	11	31,2	10	1	55	12	100	19	12
2	0	23	2,4	20	3	50	24	200	38	24
3	0	34	33.6	30	5	45	36	300	57	36
4	0	46	4,8	40	7	40	48	400	76	48
5	0	57	36,0	50	9	36	0	500	96	0
6	1	9	7,2	60	11	31	12	600	115	12
7	1	20	38,4	70	13	26	24	700	134	24
8	1	32	9,6	80	15	21	36	800	153	36
9	1	43	40,8	90	17	16	48	900	172	48
10	1	55	12,0	100	19	12	0	1000	192	0

Example Table XIV.

Let it be required to convert the fraction $\frac{1854}{1875}$ into Saura time.

By Table XIV, -	1000	-	192^{d}	0^{d}	0^{p}
	800	-	153	36	0
	50	-	9	36	0
	4	-		46	4,8
Saura time sought	-	-	355	58	4,8

TABLE XV.

I.

Degrees of ☉'s motion reduced to Saura time.

Degrees.	Days.	′ ″ ‴	Days, Dandas, Castacalas.	
1	12	1	0	12
2	24	2	0	24
3	36	3	0	36
4	48	4	0	48
5	60	5	1	0
6	72	6	1	12
7	84	7	1	24
8	96	8	1	36
9	108	9	1	48
10	120	10	2	0
20	240	20	4	0
30	360	30	6	0
		40	8	0
		50	10	0
		60	12	0

II.

Saura time reduced to degrees, &c. of ☉'s motion.

Months of 30 days.	°	′	Days, Dandas, Casta.	′ ″ ‴	″ ‴ ⁗
1	2	30	1	0	5
2	5	0	2	0	10
3	7	30	3	0	15
4	10	0	4	0	20
5	12	30	5	0	25
6	15	0	6	0	30
7	17	30	7	0	35
8	20	0	8	0	40
9	22	30	9	0	45
10	25	0	10	0	50
11	27	30	20	1	40
12	30	0	30	2	30
			40	3	20
			50	4	10
			60	5	0

Example Table XIII.

Let it be required to convert 16′ 44″ 24‴ of Jupiter's motion, into Solar Sydereal time.

	D.	G.	V.	P.
10′ - -	2	0	20	41,5791
6 - -	1	12	12	24,9474
40″ - -		8	1	22,7719
4 - -			48	8,2772
20‴ - -			4	0,6897
4 - -				48,1380
Solar Sydereal time sought - -	3	21	27	26,4033

Example Table XV.

I. Degrees into Time.

Let it be required to convert 27° 31′ 6‴ of the *Sun's* motion into Saura time, of 1 day to 1°.

	D.	G.	V.
20° -	240	0	0
7 -	84	0	0
30′ -	6	0	0
1 -		12	0
6‴ -		1	12
Time sought -	330	13	12

or 11 months of 30 days 0^d 13^g 12^v.

II. Time into Degrees.

Let it be required to coovert 11 months (of 30 days or 330^d), 0^d 13^g 12^v into degrees.

	°	′	″	‴
11 months -	27	30	0	0
0 days -	0	0	0	0
10 gud. -	0	0	50	0
3 -	0	0	15	0
10 vig. -	0	0	0	50
2	0	0	0	10
Degrees, &c. sought -	27	31	6	0

TABLE XVI.

For converting Saura time of one day to a degree, to mean Solar Sydereal time, the year being 365d 15g 31v 15p.

I				II			III	
Saura Days.	Days.	Guddias.	Vigud.	Saura Dandas	Guddias.	Vigud.	Saura Palas.	Vigud.
1	1	0	52,58681	1	1	0,87641	1	1,01460
2	2	1	45,17361	2	2	1,75289	2	2,02921
3	3	2	37,76042	3	3	2,62934	3	3,04381
4	4	3	30,34722	4	4	3,50578	4	4,05842
5	5	4	22,93403	5	5	4,38223	5	5,07303
6	6	5	15,52083	6	6	5,25868	6	6,08763
7	7	6	8,10764	7	7	6,13513	7	7,10221
8	8	7	0,69444	8	8	7,01157	8	8,11684
9	9	7	53,28124	9	9	7,88802	9	9,13145
10	10	8	45,86805	10	10	8,76447	10	10,14607
20	20	17	31,73610	20	20	17,52894	20	20,29215
30	30	26	17,60415	30	30	26,29340	30	30,43822
40	40	35	3,47220	40	40	35,05787	40	40,58429
50	50	43	49,34025	50	50	43,82234	50	50,73037
60	60	52	35,20835	60	60	52,58681	60	60,87644
70	71	1	21,07640					
80	81	10	6,94145					
90	91	18	52,81250					
100	101	27	38,68055					
200	202	55	17,36110					
300	304	22	56,04165					

EXAMPLE TABLE XVI.

Let it be proposed to convert 355d 49 dandas, 29,95 palas, expressed in Saura time, into Solar Sydereal time, the year being 365d 15g 31v 15p.

	Saura.	*Sydereal.*		
		D.	GUD.	VIGUD.
Column I	300d	304	22	56,04165
	50	50	43	49,34025
	5	5	4	22,93403
II	40dan.		40	35,05787
	9		9	7,88802
	20palas.			20.29215
III	9			9,13145
	0,9			0,91345
	0,05			0,05073
Total in Solar Sydereal time		361	1	21,64960

TABLE XVII.

Exhibiting the progress of Jupiter in degrees, &c. for Solar years of 365^D 15^d 31^p 31^c *corresponding to Vrihaspa'i years of* 361^D 2^d 4^p 44^c,2329 *as deduced from the precepts of the Surriah Siddhanta and Tika.*

	I.						II.				
Solar Years.	Jupiter's mean heliocentric Revolutions and parts.						Corresponding duration of ♃'s time, its year being 361^D 2^d 4^p 44^c,2329 of Solar time, the rest being expressed in Solar time.				
	Rev.	Signs.	°	′	″	‴	Yrs.	Days.	Dan.	Pal.	Cast.
1	0	1	0	21	3	36	1	4	13	26	46,7655
2	0	2	0	42	7	12	2	8	26	53	33,5310
3	0	3	1	3	10	48	3	12	40	20	20,2965
4	0	4	1	24	14	24	4	16	53	47	7,0620
5	0	5	1	45	18	0	5	21	7	13	53,8274
6	0	6	2	6	21	36	6	25	20	40	40,5929
7	0	7	2	27	25	12	7	29	34	7	27,3584
8	0	8	2	48	28	48	8	33	47	34	14,1239
9	0	9	3	9	32	24	9	38	1	1	0,8894
10	0	10	3	30	36	0	10	42	14	27	47,6552
20	1	8	7	1	12	0	20	87	28	55	35,3104
30	2	6	10	31	48	0	30	126	43	23	22,9656
40	3	4	14	2	24	0	40	168	57	51	10,6208
50	4	2	17	33	0	0	50	211	12	18	58,2760
60	5	0	21	3	36	0	60	253	26	46	45,9312
70	5	10	24	34	12	0	70	295	41	14	33,5864
80	6	8	28	4	48	0	80	337	55	42	21,2416
90	7	7	1	35	24	0	91	19	8	5	24,6639
100	8	5	5	6	0	0	101	61	22	33	12,3196

Example Table XVII.

1° Wanted the number of Jupiter's mean heliocentric revolutions and parts in 175 Solar years.

	R.	S.	°	′	″
Part I, for 100 Solar years - -	8	5	5	6	0
70 do. - - -	5	10	24	34	12
5 do. - - -	0	5	1	45	18
Answer	14	9	1	25	30

2° Wanted the time in terms of Jupiter's own year, answering to 175 Solar years.

	Y.	D.	DAN.	P.	C.
Part II, for 100 Solar years -	101	61	22	33	12,3196
70 do. - -	70	295	41	14	33,5864
5 do. - -	5	21	7	13	53,8274
As the days exceed 1 of ♃'s years -	176	378	11	1	39,7334
Subtract 1 year		361	2	4	44,2329
and add unit to the number of years. Answer	177	17	8	56	55,5004

TABLE XVIII.

Exhibiting the Epochs of expunged years of the Cycle of 60 years, from the beginning of the Cali yug to A°. 5128, in mean Solar Sydereal time.

Epochs in Christian years A. C.	Periods.	♃'s mean heliocentric Longitude. R.	S.	Years.	Days.	Dandas.	Palas.	Castacalas.
3046	1	4	8	55	128	42	31	52,0636
2960	2	11	11	141	126	28	13	34,4625
2874	3	19	2	227	124	13	55	16,8614
2788	4	26	5	313	121	59	36	59,2603
2702	5	33	8	399	119	45	18	41,6592
2616	6	40	11	485	117	31	0	24,0581
2530	7	48	2	571	115	16	42	6.4570
2444	8	55	5	657	113	2	23	48,8559
2358	9	62	8	743	110	48	5	31,2548
2272	10	69	11	829	108	33	47	13,6537
2186	11	77	2	915	106	19	28	56,0526
2100	12	84	5	1001	104	5	10	38,4515
2014	13	91	8	1087	101	50	52	20,8504
1928	14	98	11	1173	99	36	34	3,2493
1842	15	106	2	1259	97	22	15	45,6482
1756	16	113	5	1345	95	7	57	28,0471
1670	17	120	8	1431	92	53	39	10.4460
1584	18	127	11	1517	90	39	20	52,8449
1498	19	135	2	1603	88	25	2	35,2438
1412	20	142	5	1689	86	10	44	17,6427
1326	21	149	8	1775	83	56	26	0,0416
1240	22	156	11	1861	81	42	7	42,4405
1154	23	164	2	1947	79	27	49	24,8394
1068	24	171	5	2033	77	13	31	7,2383
982	25	178	8	2119	74	59	12	49,6372
896	26	185	11	2205	72	44	54	32,0361
810	27	193	2	2291	70	30	36	14,4350
724	28	200	5	2377	68	16	17	56,8339
638	29	207	8	2463	66	1	59	39,2328
552	30	214	11	2549	63	47	41	21,6317
466	31	222	2	2635	61	33	23	4,0306
380	32	229	5	2721	59	19	4	46,4295
294	33	236	8	2807	57	4	46	28,8284
208	34	243	11	2893	54	50	28	11,2273
122	35	251	2	2979	52	36	9	53,6262
36	36	258	5	3065	50	21	51	36,0251
A.D.								
50	37	265	8	3151	48	7	33	18,4240
136	38	272	11	3237	45	53	15	0,8229
222	39	280	2	3323	43	38	56	43,2218
308	40	287	5	3409	41	24	38	25,6207
394	41	294	8	3495	39	10	20	8,0196
480	42	301	11	3581	36	56	1	50,4185
566	43	309	2	3667	34	41	43	32,8174
652	44	316	5	3753	32	27	25	15,2163

♃'s mean heliocentric Longitude. R.	S.	Years.	Days.	Dandas.	Palas.	Castacalas.	Periods.	Epochs in Christian years A. D.
323	8	3839	30	13	6	57,6152	45	738
330	11	3925	27	58	48	40,0141	46	824
338	2	4011	25	44	30	22,4130	47	910
345	5	4097	23	30	12	4,8119	48	996
352	8	4183	21	15	53	47,2108	49	1082
359	11	4269	19	1	35	29,6097	50	1168
367	2	4355	16	47	17	12,0086	51	1254
374	5	1441	14	32	58	54,4075	52	1340
381	8	4527	12	18	40	36,8064	53	1426
388	11	4613	10	4	22	19,2053	54	1512
396	2	4699	7	50	4	1,6042	55	1598
403	5	4785	5	35	45	44,0031	56	1684
410	8	4871	3	21	27	26,4020	57	1770
417	11	4957	1	7	9	8,8009	58	1856
425	2	5042	364	8	22	22,1998	59	1941
432	5	5128	361	54	4	4,5987	60	2027

EXAMPLE I.

Wanted the year of the Chacra which concurs with A. Cali yugam 55 *complete*, or 56 *current*.

I.

For ♃'s mean heliocentric Longitude.

	R.	S.	°	'	"
Table XI, for 50 -	4	2	17	35	0
Do. 5 -		5	1	45	30
Bijah - -	4	7	19	20	30
Table XII			—	2	12
Subt. —	4	7	19	18	18
from +	4	7	30	to complete the	
Sign. Wanting			10	41	42

' "
50 - 2 0
5 - 12
2 12

To convert which into time.

	D.	D.	P.	C.
Table XIII, 10 -	120	20	41	34,7443
40 -	8	1	22	46,3163
1 -		12	2	4,1579
40 -		8	1	22,7719
2 -			24	4,1386
10° 41' 42" =	128	42	31	52,1296
By Table XVIII				52,0636
Difference of the Tables				0,0660

Lastly, $\frac{4^{r}\times 12+8^{s}}{60}=56$ years (♃'s.)

The first expunged year of the Chacra after the Epoch Cali yugam is, therefore, due when 55^{Y} 128^{D} 42^{d} 31^{p} 52: Solar time, have expired, and ♃'s Longitude is precisely (4^{r}) 8^{s}.

Example II.

For the nearest expunged year of the Chacra to A. Cali yugam 5129.

For the Bijah.
Table XII.

	°	'	"	‴
5000	3	20		
100		4		
20		0	48	
9			21	36
	3	25	9	36

	Y.		R.	S.	°	'	"	
Table XI,	5000	-	421	6	18	20	0	
,,	100	-	8	5	5	10	0	
,,	20	-	1	8	7	2	0	
,,	9	-		9	3	9	54	
	5129	-	432	5	3	41	54	
				—	3	25	9	36
			432	5	0	16	44	24

which shews that on the last day of the Solar year 5129 *the Epoch has passed by 16′ 44″ 24‴* of ♃'s motion, which converted into Solar time by Table XIII, give

			D.	D.	P.	C.
	10′	-	2	0	20	41,5791
	6	-	1	12	12	21,9474
	40″	-		8	1	22,7719
	4	-			48	8,2772
	20‴	-			4	0,6897
	4	-				48,1380
	Y.		3	21	27	26,4033
	5128	-	365	15	31	31
Epoch of Cshaya when ♃'s Longitude is precisely (432^{r}) 5^{s} . . . A. Cali yugam	5128	-	361	54	4	4,5967

For ♃'s years $432^{r}\times 12+5^{s}=5189$ years. Hence $5189-5129=60$, which shews that in 5129 Solar Sydereal years, there is a whole cycle or 60 ♃'s years expunged according to Astronomical computation.

Example III:

To find the cycles and years of Jupiter, the natural days, guddias, viguddias, &c. elapsed of that account on the birth of Christ.

			R.	S.	°	'	"	
By Table XI, -	3000	-	252	11	5	0	0	
	100	-	8	5	5	10	0	
	1	-	1	1	0	21	6	
	3101	-	261	5	10	31	6	
	Bijah *Sodium*		—		2	4	2	24
			261	[5	8	27	3	36

For the Bijah.

Table XII.

		°	'	"	‴
3000	-	2	0	0	
100	-		4	0	
1	-			2	24
Sodium		2	4	2	24

261
× 12
3132
+ 6

C. Y.
60)3138(52 18 the years of the remainder to be counted from Vijaya the 27th *inclusive.*
138
Remainder 18

The year sought will be the 44th called *Sadharana.* For the time due to the degrees above complete signs.

By Table XIII the degrees, &c. being 8° 27′ 3″ 36‴.

		D.	G.	V.	P.
8°	-	96	16	33	15,7954
20′	-	4	0	41	23,1531
7	-	1	24	14	29,1053
3″	-			36	6,2079
30‴	-			6	1,0316
6	-			1	12,2070

The whole time expired is therefore 3137 years of Jupiter + 101 42 12 27,5083

But it is not necessary to refer to the birth of Christ to find the Vrihaspati year corresponding to any proposed year since that Epoch, and when the name and rank of the Chacra year only are wanted, the Rule is confined to a common addition and division.

RULE.

" If the Christian year be proposed, find the corresponding one of the Cali yug by adding " 3101 thereto, the sum will be the last expired year of the same."

" Divide the expired years of the Cali yug by 86; add the quotient to the dividend; divide " again the sum by 60, the quotient will give the number of cycles expired; and to the " remainder, if the proposed year should fall less than 31 from the last expunged year of the " Chacra (found in Table XVIII) add 28; but if it falls in the 55 remaining years of a cycle " of 86 years, add 27 years, and the remainder so increased, will indicate the numeral of the " current year of the Chacra, and consequently its appropriate name."

EXAMPLE I.

Let the rank and name of the Chacra year which corresponds with A. D. 1822, be required.

		1822
	4923	+ 3101
By Table XVIII the last expunged year fell on A. C.		86)4923(57 57
4871 - -	4871	60)1980(83 180
Difference	52	0
therefore 27 are to be added.		+ 27
		27

which increased remainder, indicates at once Vijaya, the 27th year of the Chacra, as the current one.

EXAMPLE II.

Let the same be wanted for A. D. 1951.

		1951
	5052	+ 3101
By Table XVIII the last expunged year fell on A. C.		86)5052(58 58
5042 - -	5042	60)5110(85 310
Difference	10	10
which difference (being less than 31) indicates that 28 are to be added to the remainder after division by 60.		+ 28
		38

The increased remainder indicates at once *Cradhi,* the 38th year of the Cycle, as the current one.

TABLE XIX.

Exhibiting the Epochs of the expunged years of the Cycle of 60 years, agreeably to the Jyautistava, compared with those of the Surriah Siddhanta from the birth of Salivahana.

Periods from the Cali yug.	Intervals.	Years of the Cali yug.			Years from the birth of Salivahana.				Intervals.	Periods from the birth of Salivahana.	Epochs in Christian years according to the Jyautistava.
		Surriah Siddhanta	Diff.	Jyautistava.	Epochs according to the Jyautistava.						
	Y.				Y.	D.	D.	P.	Y.		
38	86	3237	+2	3239	60	363	42	0,87662	85	1	158
39	86	3323	1	3324	145	364	40	27,35993	86*	2	223
40		3409	1	3410	* 231	361	21	45,31653		3	309
41	86	3495	0	3495	316	362	20	11,80004	85	4	394
42	86	3581	—1	3580	401	363	18	38,28336	85	5	479
43	86	3667	2	3665	486	364	17	4,76668	85	6	564
44	86	3753	3	3750	* 571	0	0	0,0	85	7	649
45	86	3839	3	3836	657	361	56	49,20659	86*	8	735
46	86	3925	4	3921	742	362	55	15,68991	85	9	820
47	86	4011	5	4006	827	363	53	42,17323	85	10	905
48	86	4097	6	4091	912	364	52	8,65659	85	11	990
49	86	4183	6	4177	* 998	361	33	26,61318	86*	12	1076
50	86	4269	7	4262	1083	362	31	83,09650	85	13	1161
51	86	4355	8	4347	1168	363	30	19,57982	85	14	1246
52	86	4441	9	4432	1253	364	28	46,03614	85	15	1331
*53	86	4527	9	4518	*1339	361	10	4,02006	86*	16	1417
54	86	4613	10	4603	1424	362	8	30,50338	85	17	1502
55	86	4699	11	4688	1509	363	6	56,98670	85	18	1587
56	86	4785	12	4773	1594	364	5	23,47002	85	19	1672
57	86	4871	13	4858	1679	365	3	49,95325	85	20	1757
58	86	4957	13	4944	*1765	361	45	7,90993	86*	21	1843
59	*85	5042	13	5029	1850	362	43	34,39327	85	22	1928
60	86	5128	14	5104	1935	363	42	0,87657	85	23	2033

TABLE XX.

Of the Sun's mean motion for days.

Days.	Sun's mean motion.					Days.	Sun's mean motion.				
	s.	°	′	″	‴		s.	°	′	″	‴
1	0	0	59	8	10	1000	8	25	36	9	33
2	0	1	58	16	20	2000	5	21	12	19	7
3	0	2	57	24	31	3000	2	16	48	28	40
4	0	3	56	32	41	4000	11	12	24	38	11
5	0	4	55	40	51	5000	8	8	0	47	47
6	0	5	54	49	1	6000	5	3	36	57	20
7	0	6	53	57	11	7000	1	29	13	6	54
8	0	7	53	5	21	8000	10	24	49	16	27
9	0	8	52	13	32	9000	7	20	25	26	1
10	0	9	51	21	42	10000	4	16	1	35	34
20	0	19	42	43	23	20000	9	2	3	11	8
30	0	29	31	5	5	30000	1	18	4	46	42
40	1	9	25	26	47	40000	6	4	6	22	16
50	1	19	16	48	29	50000	10	20	7	57	50
60	1	29	8	10	10	60000	3	6	9	33	23
70	2	8	59	31	52	70000	7	22	11	8	57
80	2	18	50	53	34	80000	0	8	12	44	31
90	2	28	42	15	16	90000	4	24	14	20	5
100	3	8	33	36	57	100000	9	10	15	55	39
200	6	17	7	13	55	200000	6	20	31	51	18
300	9	25	40	50	52	300000	4	0	47	46	57
400	1	4	14	27	49	400000	1	11	3	42	36
500	4	12	48	4	47	500000	10	21	19	38	16
600	7	21	21	41	44	600000	8	1	35	33	55
700	10	29	55	18	41	700000	5	11	51	29	34
800	2	8	28	55	39	800000	2	22	7	25	13
900	5	17	2	32	36	900000	0	2	23	20	52
1000	8	25	36	9	33	1000000	9	12	39	16	31

Sun's Druva $11^{s}\ 25^{\circ}\ 25'\ 34''\ 23'''$ A. Cali yugam 4399 complete.

Generally, for all the Tables contained in this collection where a *Druva* is given, if you compute the number of natural or *Savan* days elapsed from the end of the year for which the *Druva* is given, and add to its Longitude, the Sun, or Planet's motion due to the said number of days, you will have their mean place in the Hindu Zodiac for the proposed day, at mean midnight under the Meridian of Lanca.

TABLE XXI.

Of the mean motion of the Moon, of her Apogee, with Bijah and Node: The Bijah being common to both the latter; but as the Node is taken to move in antecedentia, its Bijah is subtractive.

Days.	Moon.					Apogee.					Bijah.				Node.				
	s.	°	'	"	‴	s.	°	'	"	‴	'	"	‴	⁗	s.	°	'	"	‴
1	0	13	10	34	52	0	0	6	40	59	0	0	0	11	0	0	3	10	45
2	0	26	21	9	44	0	0	13	21	57	0	0	0	21	0	0	6	21	29
3	1	9	31	44	36	0	0	20	2	56	0	0	0	32	0	0	9	32	14
4	1	22	42	19	28	0	0	26	43	55	0	0	0	43	0	0	12	42	59
5	2	5	52	54	20	0	0	83	24	54	0	0	0	53	0	0	15	53	44
6	2	19	3	29	12	0	0	40	5	52	0	0	1	4	0	0	19	4	28
7	3	2	14	4	4	0	0	46	46	52	0	0	1	15	0	0	22	15	13
8	3	15	24	38	56	0	0	53	27	50	0	0	1	25	0	0	25	25	58
9	3	28	35	13	49	0	1	0	8	48	0	0	1	36	0	0	28	36	42
10	4	11	45	48	41	0	1	6	49	47	0	0	1	47	0	0	31	47	27
20	8	23	31	37	21	0	2	13	39	34	0	0	3	33	0	1	3	34	54
30	1	5	17	26	2	0	3	20	29	21	0	0	5	20	0	1	35	22	22
40	8	17	3	14	43	0	4	27	19	8	0	0	7	6	0	2	7	9	48
50	9	28	49	3	23	0	5	34	8	55	0	0	8	52	0	2	38	57	16
60	2	10	34	52	4	0	6	40	58	43	0	0	10	39	0	3	10	44	43
70	6	22	20	40	44	0	7	47	48	30	0	0	12	26	0	3	42	32	10
80	11	4	6	29	25	0	8	54	38	17	0	0	14	12	0	4	14	19	37
90	3	15	52	18	6	0	10	1	28	4	0	0	15	59	0	4	46	7	4
100	7	27	38	6	47	0	11	8	17	57	0	0	17	45	0	5	17	54	32

The same continued.

Days.	Moon.					Apogee.					Bijah.				Nede.				
	s.	°	′	″	‴	s.	°	′	″	‴	′	″	‴	⁗	s.	°	′	″	‴
100	7	27	38	6	47	0	11	8	17	57	0	0	17	45	0	5	17	54	32
200	3	25	16	13	33	0	22	16	35	42	0	0	35	30	0	10	35	49	4
300	11	22	54	20	19	1	3	24	53	33	0	0	53	15	0	15	53	43	36
400	7	20	32	27	5	1	14	33	11	23	0	1	11	34	0	21	11	38	8
500	3	18	10	33	52	1	25	41	29	14	0	1	28	45	0	26	29	32	40
600	11	15	48	40	38	2	6	49	47	5	0	1	46	31	1	1	47	27	12
700	7	13	26	47	25	2	17	58	4	56	0	2	4	16	1	7	5	21	44
800	3	11	4	54	11	2	29	6	22	47	0	2	22	1	1	12	23	16	16
900	11	8	43	0	55	3	10	14	40	33	0	2	39	46	1	17	41	10	48
1000	7	6	21	7	45	3	21	22	58	29	0	2	57	31	1	22	59	15	19
2000	2	12	42	15	30	7	12	45	56	57	0	5	55	3	3	15	58	10	39
3000	9	19	3	23	15	11	4	8	55	26	0	8	52	34	5	8	57	15	58
4000	4	25	24	30	55	2	25	31	53	55	0	11	50	6	7	1	56	21	18
5000	0	1	45	38	40	6	16	54	52	23	0	14	47	37	8	24	55	26	37
6000	7	8	6	46	21	10	8	17	50	52	0	17	45	9	10	17	54	31	57
7000	2	14	27	54	6	1	29	40	49	20	0	20	42	40	0	10	53	37	16
8000	9	20	49	1	49	5	21	3	47	49	0	23	41	11	2	3	52	42	36
9000	4	27	10	9	33	9	12	26	46	18	0	26	37	43	3	26	51	47	55
10000	0	3	31	17	16	1	3	49	44	46	0	29	35	14	5	19	50	53	15
20000	0	7	2	34	33	2	7	39	29	33	0	59	10	29	11	9	41	46	29
30000	0	10	33	51	49	3	11	29	14	19	1	28	45	43	4	29	32	39	44
40000	0	14	5	9	6	4	15	18	59	6	1	58	20	57	10	19	23	32	59
50000	0	17	36	26	22	5	19	8	43	52	2	28	6	12	4	9	14	26	13
60000	0	21	7	43	39	6	22	58	28	38	2	57	31	26	9	29	5	19	28
70000	0	24	39	0	55	7	26	48	13	25	3	27	6	40	3	18	56	12	43

The same continued.

Days.	Moon.					Apogee.					Bijah.				Node.				
	s.	°	'	''	'''	s.	°	'	''	'''	'	''	'''	''''	s.	°	'	''	'''
70000	0	24	39	0	55	7	26	48	13	25	3	27	6	40	3	18	56	12	43
80000	0	28	10	18	12	9	0	37	58	11	3	56	41	55	9	8	47	5	57
90000	1	1	41	35	28	10	4	27	42	57	4	26	17	9	2	28	37	59	12
100000	1	5	12	52	45	11	8	17	27	44	4	55	52	23	8	18	28	52	26
200000	2	10	25	45	30	10	16	34	55	28	9	51	44	46	5	6	57	44	53
300000	3	15	38	38	14	9	25	52	23	13	14	47	37	9	1	25	26	37	19
400000	4	20	51	30	59	9	3	9	50	56	19	43	29	32	10	13	55	29	46
500000	5	26	4	23	44	8	11	27	18	39	24	39	21	55	7	2	24	22	12
600000	7	1	17	16	29	7	19	44	46	23	29	35	14	18	3	20	53	14	39
700000	8	6	30	9	24	6	28	2	14	7	34	31	6	41	0	9	22	7	5
800000	9	11	43	1	59	6	6	19	41	51	39	26	57	4	8	27	50	59	32
900000	10	16	55	54	43	5	14	37	9	35	44	27	51	27	5	16	19	51	58
1000000	11	22	8	47	30	4	22	54	37	19	49	18	43	50	2	4	48	44	25
						°	'	''	'''										
Druvas.	11	5	48	37	29	4	15	26	17	0	1	29	0	54	0	6	12	9	0 A.Cali yug 4390 complete.

TABLE XXII.

Of the Sun's Anomalistic Equation.

N. B.—To find the Argument of this Table, subtract the Sun's mean place from that of his Apogee for the time given.

Supplement mean Anomaly.												
°	′	+ 0s — VIs			+ Is — VIIs			+ 2 — VIII			°	′
		°	′	″	°	′	″	°	′	″		
0	0	0	0	0	1	6	3	1	53	26	30	0
3	45	0	8	44	1	13	18	1	57	22	26	15
7	30	0	17	24	1	20	13	2	0	50	22	30
11	15	0	25	58	1	26	47	2	3	46	18	45
15	0	0	34	24	1	32	57	2	6	11	15	0
18	45	0	42	38	1	38	44	2	8	4	11	15
22	30	0	50	40	1	44	5	2	9	26	7	30
26	15	0	58	29	1	48	59	2	10	15	3	45
30	0	1	6	3	1	53	26	2	10	31	0	0
°	′	— XIs + Vs			— Xs + IVs			— IX + III			°	′
Supplement mean Anomaly.												

TABLE XXIII.

Of the Moon's Anomalistic Equation.

N. B.—To find the Argument, subtract the Moon's mean place from that of her Apogee.

Supplement mean Anomaly.												
°	′	+ 0s — VIs			+ Is — VIIs			+ IIs — VIIIs			°	′
		°	′	″	°	′	″	°	′	″		
0	0	0	0	0	2	32	0	4	22	30	30	0
3	45	0	19	59	2	48	48	4	31	46	26	15
7	30	0	39	52	3	4	52	4	39	56	22	30
11	15	0	59	31	3	20	8	4	46	50	18	45
15	0	1	18	54	3	34	30	4	52	32	15	0
18	45	1	37	53	3	48	1	4	56	59	11	15
22	30	1	56	25	4	0	33	5	0	13	7	30
26	15	2	14	29	4	12	3	5	2	9	3	45
30	0	2	32	0	4	22	30	5	2	46	0	0
°	′	— XIs + Vs			— Xs + IVs			— IX′ + III			°	′
Supplement mean Anomaly.												

TABLE XXIV.

OF MARACANDA.

Solar Equations. *Ravi P'hala.*

Extracted from Mr. Davis' Paper on the Astronomical Computations of the Hindus.

Asiat. Res. Vol. II; *page* 255.

ARGUMENT, THE SUN'S ANOMALY.

Anomaly.	Equation of the mean to the true place.			Equation of the mean to the true motion.		Anomaly.	Equation of the mean to the true place.			Equation of the mean to the true motion.		Anomaly.	Equation of the mean to the true place.			Equation of the mean to the true motion.	
	°	′	″	′	″		°	′	″	′	″		°	′	″	′	″
1		2	20	2	18	31	1	8	—	1	55	61	1	54	30	1	4
2		4	40	2	18	32	1	9	57	1	53	62	1	55	34	1	0
3		7	—	2	18	33	1	11	57	1	53	63	1	56	35		58
4		9	19	2	17	34	1	13	47	1	51	64	1	57	34		57
5		11	37	2	17	35	1	15	40	1	51	65	1	58	34		55
6		13	56	2	17	36	1	17	32	1	49	66	1	59	30		55
7		16	15	2	16	37	1	19	23	1	47	67	2	—	23		52
8		18	33	2	16	38	1	21	11	1	45	68	2	1	14		49
9		20	51	2	15	39	1	22	57	1	43	69	2	2	4		46
10		23	7	2	14	40	1	24	42	1	42	70	2	2	51		43
11		25	23	2	14	41	1	26	26	1	40	71	2	3	35		41
12		27	39	2	13	42	1	28	7	1	38	72	2	4	17		39
13		29	55	2	13	43	1	29	46	1	36	73	2	4	57		37
14		32	10	2	12	44	1	31	23	1	34	74	2	5	35		35
15		34	24	2	11	45	1	32	58	1	32	75	2	6	12		32
16		36	37	2	11	46	1	34	32	1	30	76	2	6	45		31
17		38	39	2	10	47	1	36	4	1	29	77	2	7	17		28
18		41	1	2	9	48	1	37	35	1	28	78	2	7	45		25
19		43	12	2	8	49	1	39	6	1	28	79	2	8	12		23
20		45	22	2	7	50	1	40	36	1	26	80	2	8	35		22
21		47	31	2	6	51	1	42	3	1	23	81	2	8	58		20
22		49	39	2	6	52	1	43	26	1	19	82	2	9	18		18
23		51	47	2	5	53	1	44	45	1	16	83	2	9	39		15
24		53	53	2	3	54	1	46	2	1	14	84	2	9	51		12
25		55	57	2	2	55	1	47	17	1	13	85	2	10	3		10
26		58	1	2	1	56	1	48	33	1	13	86	2	10	13		8
27	1	—	2	2	—	57	1	49	47	1	12	87	2	10	20		6
28	1	2	53	1	58	58	1	51	—	1	11	88	2	10	27		4
29	1	4	3	1	57	59	1	52	12	1	11	89	2	10	31		1
30	1	6	2	1	56	60	1	53	25	1	8	90	2	10	32		0

These, and preceding Tables, were constructed for the same end. The present are adapted to Maracanda's Rules: the former to Vavilala Cuchinna's, with a different Argument. Attention is to be paid when using Maracanda's, whether the Equation be additive or subtractive. Vavilala's leave no doubt on the subject, but they do not exhibit the Equation from mean to true motion; though the same may be worked by their means.

TABLE XXV.

Lunar Equations. *Chandra P'hala.*

Vide Notes preceding Table.

ARGUMENT, THE MOON'S ANOMALY.

Anomaly.	Equation of the mean to the true place.			Equation of the mean to the true motion.		Anomaly.	Equation of the mean to the true place.			Equation of the mean to the true motion.		Anomaly.	Equation of the mean to the true place.			Equation of the mean to the true motion.	
	°	′	″	′	″		°	′	″	′	″		°	′	″	′	″
1		5	20	69	39	31	2	36	37	59	20	61	4	25	26	33	41
2		10	40	69	38	32	2	41	11	58	41	62	4	27	36	32	39
3		16	—	69	33	33	2	45	36	58	—	63	4	29	59	31	35
4		21	19	69	28	34	2	49	58	57	19	64	4	32	19	30	29
5		26	36	69	21	35	2	54	20	56	37	65	4	34	37	29	22
6		31	54	69	13	36	2	58	30	55	56	66	4	36	47	28	13
7		37	12	69	4	37	3	2	54	55	14	67	4	38	54	27	7
8		42	29	68	54	38	3	7	5	54	30	68	4	40	54	26	1
9		47	44	68	43	39	3	11	12	53	41	69	4	42	50	24	55
10		52	58	68	28	40	3	15	16	52	58	70	4	41	40	23	49
11		58	11	68	11	41	3	19	18	51	26	71	4	46	24	22	42
12	1	3	23	67	52	42	3	23	24	50	57	72	4	48	5	21	34
13	1	8	40	67	35	43	3	27	26	50	48	73	4	49	38	20	24
14	1	13	45	67	17	44	3	30	54	49	46	74	4	51	9	19	14
15	1	18	53	66	55	45	3	34	39	48	54	75	4	52	53	18	3
16	1	24	—	66	38	46	3	38	21	48	—	76	4	53	54	16	51
17	1	29	5	66	18	47	3	41	58	47	5	77	4	55	6	15	38
18	1	34	9	65	57	48	3	45	32	46	9	78	4	56	15	14	25
19	1	39	10	65	36	49	3	48	59	45	13	79	4	57	17	13	14
20	1	44	9	65	14	50	3	52	24	44	19	80	4	58	13	12	3
21	1	49	17	64	50	51	3	55	46	43	27	81	4	59	6	10	53
22	1	54	3	64	24	52	3	59	2	42	32	82	4	59	53	9	41
23	1	58	3	63	56	53	4	2	13	41	37	83	5	—	27	8	34
24	2	3	47	63	24	54	4	5	18	40	41	84	5	1	8	7	14
25	2	8	35	62	53	55	4	8	18	39	44	85	5	1	40	6	2
26	2	13	22	62	22	56	4	11	16	38	47	86	5	2	3	4	51
27	2	18	6	61	48	57	4	14	11	37	50	87	5	2	20	3	40
28	2	22	47	61	13	58	4	17	—	36	51	88	5	2	36	2	37
29	2	27	35	60	35	59	4	19	46	35	48	89	5	2	44	1	44
30	2	32	2	59	56	60	4	22	29	34	48	90	5	2	48	—	—

TABLE XXVI.

Being the first of the Vakium process.

This Table gives the Druva of the Moon's true place and her true motion for every day in a Devaram, or 248. days. Communicated by Audy Sashya Sastra.

Days.	Moon's Phala			☽'s true motion in one day.	Days.	Moon's Phala			☽'s true motion in one day.	Days.	Moon's Phala			☽'s true motion in one day.
	s.	°	′	′		s.	°	′	′		s.	°	′	′
1	0	12	3	723	36	3	19	39	807	71	7	7	51	855
2	0	24	9	726	37	4	3	21	822	72	7	21	58	847
3	1	6	22	733	38	4	17	15	834	73	8	5	55	837
4	1	18	44	742	39	5	1	20	845	74	8	19	40	825
5	2	1	19	755	40	5	15	33	853	75	9	3	10	810
6	2	14	9	770	41	5	29	51	858	76	9	16	25	795
7	2	27	13	784	42	6	14	10	859	77	9	29	21	779
8	3	10	33	800	43	6	23	27	857	78	10	12	8	764
9	3	21	9	816	44	7	12	37	850	79	10	21	39	751
10	4	7	58	829	45	7	26	39	842	80	11	6	58	739
11	4	21	58	840	46	8	10	30	831	81	11	19	8	730
12	5	6	8	850	47	8	24	7	817	82	0	1	13	725
13	5	20	25	857	48	9	7	29	802	83	0	13	15	722
14	6	4	44	859	49	9	20	35	786	84	0	25	19	724
15	6	19	2	858	50	10	3	26	771	85	1	7	27	728
16	7	3	15	853	51	10	16	2	756	86	1	19	43	736
17	7	17	22	847	52	10	28	26	744	87	2	2	10	747
18	8	1	17	835	53	11	10	40	734	88	2	14	49	759
19	8	15	1	824	54	11	22	46	726	89	2	27	43	774
20	8	28	29	808	55	0	4	49	723	90	3	10	53	790
21	9	11	42	793	56	0	16	52	723	91	3	24	18	805
22	9	24	40	778	57	0	28	58	726	92	4	7	58	820
23	10	7	23	763	58	1	11	10	732	93	4	21	52	834
24	10	19	52	749	59	1	23	31	741	94	5	5	56	844
25	11	2	10	738	60	2	6	5	754	95	5	20	8	852
26	11	14	19	729	61	2	18	52	767	96	6	4	26	858
27	11	20	24	725	62	3	1	55	783	97	6	18	45	859
28	0	8	26	722	63	3	15	14	799	98	7	3	2	857
29	0	20	30	724	64	3	28	47	813	99	7	17	13	851
30	1	2	38	728	65	4	12	35	828	100	8	1	17	844
31	1	14	55	737	66	4	26	34	839	101	8	15	8	831
32	1	27	23	748	67	5	10	44	850	102	8	28	47	819
33	2	10	4	761	68	5	24	59	855	103	9	12	10	803
34	2	23	0	776	69	6	9	17	858	104	9	25	18	788
35	3	6	12	792	70	6	23	36	859	105	10	8	11	773

Days.	Moon's P'ha/a			☽'s true motion in one day.	Days.	Moon's P'ha/a			☽'s true motion in one day.	Days.	Moon's P'ha/a			☽'s true motion in one day.
	s.	°	'	'		s.	°	'	'		s.	°	'	'
106	10	20	48	757	155	8	5	52	844	204	5	15	7	842
107	11	3	14	746	156	8	19	46	834	205	5	29	17	850
108	11	15	28	736	157	9	3	26	820	206	6	13	34	857
109	11	27	36	728	158	9	16	51	805	207	6	27	53	859
110	0	9	39	723	159	10	0	1	790	208	7	12	11	858
111	0	21	41	722	160	10	12	55	774	209	7	26	24	853
112	1	3	46	725	161	10	25	34	759	210	8	10	29	845
113	1	15	58	732	162	11	8	1	747	211	8	24	23	834
114	1	28	18	740	163	11	20	17	736	212	9	8	5	822
115	2	10	50	752	164	0	2	25	728	213	9	21	32	807
116	2	23	36	766	165	0	11	29	724	214	10	4	44	792
117	3	6	37	781	166	0	26	31	722	215	10	17	40	776
118	3	19	54	797	167	1	8	36	725	216	11	0	21	761
119	4	3	26	812	168	1	20	46	730	217	11	12	49	748
120	4	17	12	826	169	2	3	5	739	218	11	25	6	737
121	5	1	11	839	170	2	15	36	751	219	0	7	14	728
122	5	15	19	848	171	2	28	20	764	220	0	19	18	724
123	5	29	34	855	172	3	11	19	779	221	1	1	20	722
124	6	13	52	859	173	3	24	34	795	222	1	13	25	725
125	6	28	10	858	174	4	8	4	810	223	1	25	34	729
126	7	12	25	855	175	4	21	49	825	224	2	7	52	738
127	7	26	38	848	176	5	5	46	837	225	2	20	21	749
128	8	10	32	839	177	5	19	53	847	226	3	3	4	763
129	8	24	18	826	178	6	4	8	855	227	3	16	2	778
130	9	7	50	812	179	6	18	27	859	228	3	29	15	793
131	9	21	7	797	180	7	2	45	858	229	4	12	43	803
132	10	4	8	781	181	7	17	0	855	230	4	26	27	824
133	10	16	54	766	182	8	1	10	850	231	5	10	21	835
134	10	29	26	752	183	8	15	9	831	232	5	24	29	847
135	11	11	46	740	184	8	28	57	828	233	6	8	42	853
136	11	23	58	732	185	9	12	30	813	234	6	23	0	858
137	0	6	3	725	186	9	25	49	799	235	7	7	19	859
138	0	18	5	722	187	10	8	52	783	236	7	21	36	857
139	1	0	8	723	188	10	21	39	767	237	8	5	46	850
140	1	12	16	728	189	11	4	13	754	238	8	19	46	840
141	1	24	30	734	190	11	16	34	741	239	9	3	35	829
142	2	6	56	746	191	11	28	46	732	240	9	17	11	816
143	2	19	33	757	192	0	10	52	726	241	10	0	31	800
144	3	2	26	773	193	0	22	55	723	242	10	13	35	781
145	3	15	34	788	194	1	4	58	723	243	10	26	25	770
146	3	28	57	803	195	1	17	4	726	244	11	9	0	755
147	4	12	36	819	196	1	29	18	734	245	11	21	22	742
148	4	26	27	831	197	2	11	42	744	246	0	3	35	733
149	5	10	31	844	198	2	24	18	756	247	0	15	41	725
150	5	24	[illegible]	851	199	3	7	9	771	248	0	27	44	723
151	6	8	59	[illegible]	200	3	20	15	786					
152	6	23	18	859	201	4	3	37	802					
153	7	7	36	858	202	4	17	14	817					
154	7	21	48	852	203	5	1	5	831					

TABLE XXVII, Part I.

Being the second used in the Vakium, or Solar process, and called by the Tamul Astronomers the Yoghiadi *Table, &c.*

	Solar months.	Dates.	Equation for 8 days in calas.			Solar months.	Dates.	Equation for 8 days in calas.	
1	Chaitram.	1	11	0	7	Arpesi.	1	1	6
♈	—	9	14		♎	+	9	2	
	or	17	16			or	17	3	
	Vaisa'cha.	25	17			Cartica.	25	5	
2	Vyassei.	1	19	1	8	Cartiga.	1	6	7
♉	—	9	21		♏	+	9	8	
	or	17	22			or	17	9	
	Jaisht'a.	25	24			Margasiras.	25	10	
3	Auni.	1	24	2	9	Margali.	1	10	8
♊	—	9	25		♐	+	9	11	
	or	17	25			or	17	11	
	A'shád'ha.	25	24			Paushia.	25	11	
4	Audi.	1	24	3	10	Tye.	1	11	9
♋	—	9	23		♑	+	9	9	
	or	17	22			or	17	8	
	Sravana.	25	21			Mágha.	25	7	
5	Auvapi.	1	19	4	11	Maussi.	1	6	10
♌	—	9	17		♒	+	9	4	
	or	17	15			or	17	2	
	Bha'dra.	25	13			Phalguna.	25	0	
6	Paratasi.	1	11	5	12	Poongoni.	1	2	11
♍	—	9	8		♓	—	9	4	
	or	17	6			or	17	7	
	Aswina.	25	3			Chitra.	25	10	

How to find by this Table the Equation due to any proposed day.

1º Convert the number of months and days elapsed since the origin Chaitram, the former into their respective signs, the latter into degrees.

2º If the month began in the day (after Sun rise) deduct the guddias as calas, which are wanting to complete the day on which the month begun, whatever be the date in the said month for which you work. And if it commenced during the night, add the same. Or if during day time subtract 1 degree; and add the complement of initial root to 60 guddias converted into calas.

3º To find the Equation for one day. Divide the Equation given in the Table by 8; and either add or subtract the quotient, as the given month may require. That is, add from the beginning of Arpesi to the end of Maussi; and subtract from the beginning of Poongoni to the end of Paratasi. Multiply the Equation for *one* day by the number of days you require in the interval of 8 days; the product is the Equation required. The calas registered in the 4th column, are the sum of the Equations *for 8 days given in advance.* Thus 11 calas found opposite to 1st Chaitram, shew that on the 8th day of that month, 11 calas will be due.

TABLE XXVII, PART 2.

Containing the Arguments of the Sun's Anomalistic Equation for the first day of every month in the year; and for finding the same, add his true diurnal motion for every day in each month by Table XXII or XXIV.

Signs. Current.	Signs. Complete.	Types.	Tamul names, Solar months.	Bengal names, Solar months.	Quadrant of Anomaly.	Place of the Sun on the 1st of each month, relatively to his Apogee or Perigee. s.	°	'	"		☉'s Equation. ±	☉'s true diurnal motion + than his mean, or 59' 8".
1	12	♈	Chaitram	Vaisa'cha		2	17	17	20	Supplement of	+	—
2	1	♉	Vyassei	Jaish'ta	IV	1	17	17	20	Anomaly to	+	—
3	2	♊	Auni	A'sha'd'ha		0	17	17	20	360°	±	— 18th Minimum.
4	3	♋	Audi	Sravana		0	12	42	40		—	—
5	4	♌	Auvani	Bha'dra	I	1	12	42	40	Anomaly.	—	—
6	5	♍	Paratasi	Aswina		2	12	42	40		—	∓ 18th 1st Mean.
7	6	♎	Arpesi	Cartica		2	17	17	20	Distance from	—	+
8	7	♏	Cartiga	Margasiras	II	1	17	17	20	Perigee.	—	+
9	8	♐	Margali	Paushia		0	17	17	20	—	∓	+ 18th Maximum.
10	9	♑	Tye	Mágha		0	12	42	40	Distance from	+	+
11	10	♒	Maussi	Phalguna	III	1	12	42	40	Perigee.	+	+
12	11	♓	Poongoni	Chitra		2	12	42	40	+	+	± 18th 2d Mean.

Explanation and use of the 2d Part.

This second part of Table XXVII was constructed for the purpose of finding the Sun's Anomalistic Equation, his true diurnal motion, his Arca Bhagábala, and that of the Moon, for any day in the year; which the first only supplies in part.

The quantities registered in the 5th column are the Arguments of the Sun's Equation for the first day of every month, to be used either with Table XXII (of Varilala Cuchinna) or XXIV (of Maracanda).

The positive and negative Signs proper to the Equation sought, are to be taken as given in the 6th column and not as in the Tables referred to, observing that they pass from + to — on or near the 18th of Auni; and from — to + about the 18th Margali, for the reasons given in the second Part of the Key to the Siddhanta Chandra Mana; Article 2, page 127. (*)

(*) E. G. Take Argument 1st Auvani - 1 s. 12° 42' 40" Anomaly.
12
Supplement Anomaly - 11 17 17 20 Argument Table XXII.
Equation subtractive.
Do. 1st Maussi - 1 12 42 40 dist. from Perigee +
Add 6
Anomaly — 7 12 42 40
12
Supplement Anomaly - 4 17 17 20 Argument Table XXII.
Equation additive.

For obtaining the Sun's Equation and diurnal motion on the intermediate days of each month, his mean motion for days (as given in Table XX) is to be applied ± to the Argument of the first day as it goes on increasing or decreasing in that particular Quadrant of Anomaly.

The positive and negative Signs registered in the 7th column, indicate whether the Sun's true be greater or less than his mean diurnal motion, or 59′ 8″. And the Equation referring thereto in Tables XXII or XXIV (to be obtained by the same Argument) are to be used accordingly, without any regard to the Signs exhibited in those Tables.

The whole of the second part of Table XXVII is computed for the beginning of the 4941st Solar year of the Cali yug (11th April A. D. 1839) when the Sun's Apogee, according to Hindu theory, will lie in 2ˢ 17° 17′ 20″ from the beginning of the Solar Sydereal Zodiac; but it may be adapted to any position of the Sun's Apsis, as follows:

As the Apogee is supposed to move at the rate of 1′ in 517 years, its distance from the first point in Mesha ♈ will be 2ˢ 17° 17′ 20″ + 1′ in the year 4940 + 517 complete, for the same reason that it was 2ˢ 17° 17′ 20″ — 1′ in the year 4940 — 517. *That* and all other Arguments are therefore to be rectified on the same scale by a rule of proportion.

But as in the 5th column, the ☉'s place is given relatively to his Apogee and Perigee, the increment so obtained is to be added in the 4th and 2d; and subtracted in the 1st and 3d Quadrants of Anomaly, and the contrary if it be a decrement, or for anterior times.

EXAMPLE.

Let the Sun's Equation, true diurnal motion, and Arca Bhagábala, as well as that of the Moon, be required for the 15th Chaitram complete of the 4941st year of the Cali yug current.

	s.	°	′	″
Argument of Equation, 1st Chaitram, Table XXVII, part 2 -	2	17	17	20
Subtract ☉'s mean motion for 15 days, Table XX -	—	14	47	3
Manda Kendra, 15th Chaitram - - -	2	2	30	17
	or	62	30	17

with which Argument, referring to Maracanda's Table (XXIV) we find the Sun's Anomalistic Equation 1° 56′ 4″, which is *positive* on account of the sign + in the 6th column of the present Table, and according to the well known precept the Solar Arca Bhagábala will be $+\frac{1^\circ\,56'\,4''}{365} = +\,19''$

and the Lunar - - $\frac{1^\circ\,36'\,4''}{27} = +\,4'\,17''$.

The Equation of the Sun's true to mean motion, answering to the same Argument in the same Table, is

	′	″
Table, is - - - - - - -	—	59
☉'s mean motion - - - - - -	59	8
Sun's true diurnal motion, 15th Chaitram - -	58	9

N. B.—It is to be understood, however, that both parts of Table XXVII only give approximations, with which the Tamul Astronomers are contented.

TABLE XXVIII.

Of the Sun's true motion *for* 366 *days, (3d of the Vukiam). Communicated by R. Audy Sashya Brahmini.*

♈ Vaisácha or Chaitıam.			♉ Jaish'ta or Vyassei.			♊ A'shád'ha or Auni.			♋ Sravana or Audi.			♌ Bha'dra or Auvani.			♍ Aswina or Paratasi.		
D.	Tr. motion.		D.	Tr. motion.		D.	Tr. motion.		D.	Tr. motion.		D.	Tr. motion.		D.	Tr. motion.	
	′	″		′	″		′	″		′	″		′	″		′	″
1	58	40	1	57	38	1	56	59	1	56	55	1	57	27	1	58	26
2	58	38	2	57	36	2	56	58	2	56	56	2	57	29	2	58	28
3	58	36	3	57	35	3	56	57	3	56	57	3	57	31	3	58	30
4	58	34	4	57	34	4	56	56	4	56	58	4	57	33	4	58	32
5	58	31	5	57	32	5	56	55	5	56	59	5	57	35	5	58	34
6	58	28	6	57	31	6	56	54	6	57	0	6	57	36	6	58	36
7	58	25	7	57	29	7	56	54	7	57	1	7	57	38	7	58	88
8	58	23	8	57	27	8	56	53	8	57	2	8	57	39	8	58	40
9	58	21	9	57	25	9	56	53	9	57	3	9	57	41	9	58	42
10	58	19	10	57	24	10	56	52	10	57	4	10	57	43	10	58	44
11	58	17	11	57	22	11	56	52	11	57	5	11	57	45	11	58	46
12	58	15	12	57	21	12	56	52	12	57	6	12	57	46	12	58	48
13	58	12	13	57	20	13	56	52	13	57	7	13	57	48	13	58	50
14	58	10	14	57	19	14	56	51	14	57	8	14	57	50	14	58	53
15	58	8	15	57	17	15	56	51	15	57	9	15	57	52	15	58	56
16	58	7	16	57	16	16	56	51	16	57	10	16	57	54	16	58	59
17	58	5	17	57	15	17	56	50	17	57	11	17	57	56	17	59	2
18	58	3	18	57	13	18	56	50	18	57	12	18	57	58	18	59	5
							Minimum.									Mean.	
19	58	1	19	57	12	19	56	50	19	57	13	19	58	0	19	59	8
20	57	58	20	57	11	20	56	50	20	57	14	20	58	2	20	59	11
21	57	56	21	57	10	21	56	50	21	57	15	21	58	4	21	50	14
22	57	54	22	57	9	22	56	50	22	57	16	22	58	6	22	50	17
23	57	52	23	57	7	23	56	51	23	57	17	23	58	8	23	59	20
24	57	50	24	57	6	24	56	51	24	57	18	24	58	10	24	59	23
25	57	48	25	57	4	25	56	51	25	57	19	25	58	12	25	59	26
26	57	46	26	57	3	26	56	52	26	57	20	26	58	14	26	59	29
27	57	45	27	57	2	27	56	52	27	57	21	27	58	16	27	59	32
28	57	43	28	57	1	28	56	52	28	57	22	28	58	18	28	59	35
29	57	41	29	57	0	29	56	53	29	57	23	29	58	20	29	59	38
30	57	39	30	56	59	30	56	54	30	57	24	30	58	22	30	59	40
31	57	38	31	56	59	31	56	54	31	57	25	31	58	24	31	59	42
						32	56	55									

This Table answers for the beginning of the year 4924 of the Cali yug (A. D. 1822) when the place of the Sun's Apogee in the Hindu Zodiac was 2ˢ 17° 17′ 18″ and its Tropical Longitude (or *Ravi Sayana*) 3ˢ 7° 7′ 43″. As the Sun's Apogee is supposed to move only at the rate of 1′ in 517 years, the Peninsula Astronomers conceive that it answers sufficiently well for many centuries past and to come, for computing the Kalendar.

♎ Cártiga or Arpesi.			♏ Ma'rgasi'ras or Cartiga.			♐ Paushia or Margali.			♑ Ma'gha or Tye.			♒ P'ha'lguna or Maussi.			♓ Chitra or Poongoni.		
D.	Tr. motion.		D.	Tr. motion.		D.	Tr. motion.		D.	Tr. motion.		D.	Tr. motion.		D.	Tr. motion.	
	′	″		′	″		′	″		′	″		′	″		′	″
1	59	44	1	60	44	1	61	23	1	61	24	1	60	53	1	59	53
2	59	46	2	60	46	2	61	23	2	61	23	2	60	51	2	59	51
3	59	48	3	60	48	3	61	24	3	61	22	3	60	49	3	59	49
4	59	50	4	60	50	4	61	24	4	61	21	4	60	47	4	59	46
5	59	52	5	60	52	5	61	25	5	61	20	5	60	45	5	59	43
6	59	54	6	60	54	6	61	25	6	61	19	6	60	43	6	59	40
7	59	56	7	60	56	7	61	25	7	61	18	7	60	41	7	59	37
8	59	58	8	60	53	8	61	25	8	61	17	8	60	39	8	59	34
9	60	0	9	61	0	9	61	25	9	61	16	9	60	37	9	59	31
10	60	2	10	61	2	10	61	26	10	61	15	10	60	35	10	59	29
11	60	4	11	61	3	11	61	26	11	61	14	11	60	33	11	59	26
12	60	6	12	61	4	12	61	26	12	61	13	12	60	31	12	59	23
13	60	8	13	61	5	13	61	26	13	61	12	13	60	29	13	59	20
14	60	10	14	61	6	14	61	26	14	61	11	14	60	27	14	59	17
15	60	12	15	61	7	15	61	26	15	61	10	15	60	25	15	59	14
16	60	14	16	61	8	16	61	26	16	61	9	16	60	23	16	59	11
17	60	16	17	61	9	17	61	26	17	61	8	17	60	21	17	59	8
							Maximum.									Mean.	
18	60	18	18	61	10	18	61	26	18	61	7	18	60	19	18	59	5
19	60	20	19	61	11	19	61	26	19	61	6	19	60	17	19	59	3
20	60	22	20	61	12	20	61	26	20	61	5	20	60	15	20	59	1
21	60	24	21	61	13	21	61	26	21	61	4	21	60	13	21	58	59
22	60	26	22	61	14	22	61	26	22	61	3	22	60	11	22	58	57
23	60	28	23	61	15	23	61	26	23	61	2	23	60	9	23	58	55
24	60	30	24	61	16	24	61	26	24	61	1	24	60	7	24	58	52
25	60	32	25	61	17	25	61	26	25	61	0	25	60	5	25	58	49
26	60	34	26	61	18	26	61	25	26	60	59	26	60	3	26	58	47
27	60	36	27	61	19	27	61	25	27	60	58	27	60	1	27	58	45
28	60	38	28	61	20	28	61	25	28	60	56	28	59	59	28	58	43
29	60	40	29	61	21	29	61	25	29	60	55	29	59	57	29	58	41
30	60	42	30	61	22	30	61	25				30	59	55	30	58	40

TABLE XXIX.

For finding the Epochs of mean Intercalations of Luni-solar months from the year 0 of the Cali yug, to any other time.

	Complete years.	I Epochs of Intercalations.						Periods.	Complete years.	II Epochs of Intercalations.						Periods.	Complete years.	III Epochs of Intercalations.				
		Y.	M.	D.	G.	V.				Y.	M.	D.	G.	V.				Y.	M.	D.	G.	V.
Succession in 19 years.	0	0	0	0	0	0	Cycles of 19 years.	1	19	18	11	22	27	25	Cycles of 10×19=190 years.	1	190	189	9	14	34	10
	3	2	8	16	3	55		2	38	37	11	14	54	50		2	380	379	6	29	8	20
	6	5	5	2	7	50		3	57	56	11	7	22	15		3	570	569	4	13	42	30
	9	8	1	18	11	45		4	76	75	10	29	49	40		4	760	759	1	28	16	40
	11	10	10	4	15	40		5	95	94	10	22	17	5		5	949	948	11	12	50	50
	14	13	6	20	23	30		6	114	113	10	14	44	30		6	1139	1138	8	27	25	0
	17	16	3	6	23	30		7	133	132	10	7	11	55		7	1329	1328	6	11	59	10
	19	18	11	22	27	25		8	152	151	9	29	39	20		8	1519	1518	3	26	33	20
								9	171	170	9	22	6	45		9	1709	1708	1	11	7	30
								10	190	189	9	14	34	10		10	1898	1897	10	25	41	40

N. B.—This Table is subject to an Equation of 3′ 50″ additive in all cases—with it the results will tally correctly with those of the Hindu Rule.

How to compute by this Table the mean intercalation due to A. Cali yugam 4923.

		Y.	M.	D.	G.	V.
4923	Take Part III for 1898 -	1897	10	25	41	40
3795						2
1123		3795	9	21	23	20
4923	Part III -	948	11	12	50	50
4744		4744	9	4	14	10
179	Part II -	170	9	22	6	45
		4915	6	26	20	55

		Y.	M.	D.	G.	V.
4923		4915	6	26	20	55
4915	Part I -	8	1	18	11	45
8		4923	8	14	32	40
	Equation -			+	3	50
Time of Intercalation - -		4928	8	14	36	30
Time by Hindu Rule (page 150) -		4928	8	14	36	29
				Difference		1

TABLE XXX.

Trigonometrical Table, to Radius 3438′.

Signs.		Periods	0^s or VI^s			Periods	I^s or VII.			Periods	II^s or VIII.			Signs.	
Degrees.			Sines	Cosines	V. sines.		Sines	Cosines	V. sines.		Sines	Cosines	V. sines.	Deg.	
°	′		′	′	′		′	′	′		′	′	′	°	′
0	0	0	000	3438	0	8	1719	2978	460	16	2978	1719	1719	30	0
3	45	1	225	3431	7	9	1910	2859	579	17	3084	1520	1918	26	15
7	30	2	449	3409	29	10	2093	2728	710	18	3177	1315	2123	22	30
11	15	3	671	3372	66	11	2267	2585	853	19	3256	1105	2333	18	45
15	0	4	890	3321	117	12	2431	2431	1007	20	3321	890	2548	15	0
18	45	5	1105	3256	182	13	2585	2267	1171	21	3372	671	2767	11	15
22	30	6	1315	3177	261	14	2728	2093	1345	22	3409	449	2989	7	30
26	15	7	1520	3084	354	15	2859	1910	1528	23	3431	225	3213	3	45
30	0	8	1719	2978	460	16	2978	1719	1719	24	3438	000	3438	0	0
Degrees.		Periods	Sines	Cosines	V. sines.	Periods	Sines	Cosines	V. sines.	Periods	Sines	Cosines	V. sines.	Deg.	
			XI^s or V.				X^s or IV.				IX^s or III.			Signs.	

Besides the method by continual bissection of an Arc of 30°, and extracting the square root, those who undertake to expound the Surriah Siddhanta have another Rule for computing the common Table of Sines.

The Prathama Jiva, or Sine of the 1st *Pinda* is supposed equal to the Arc itself; or Sine of 3° 45′ $=225''$, the Radius or Sine of 90° being 3438′, and the Cosine of the 1st Pinda, or Cosine 3° 45′ $= \sqrt{3438^2 - 225^2} = 3431$.

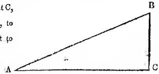
If $A-B$; A, and $A+B$ be three Arcs, whose common difference $B=3°\ 45'$. Then the Rule for computing the Table of Sines may be expressed in Algebraical characters as follows: Sine $A+B = 2$ Sine $- \frac{\text{Sine } A}{\text{Sine } B} -$ Sine AB. Thus let $A-B=3°\ 45'$ or $A+B=7°\ 30'$. Then Sine $7°\ 30' = 2 \times 225 - \frac{225'}{225} -$ Sine $0° = 450' - 1 = 449$. Next let $A = 7°\ 30'$, $B = 3°\ 45'$, $A+B = 11°\ 15'$; Then Sine $11°\ 15' = 2 \times 449' - \frac{449}{225} - 225' = 898' - 2' - 225' = 671'$. And so on of the whole Quadrant.

To see the reason of this Rule more clearly, suppose again $A=B$; then Sine $2B =$ Sine $\overline{A+B} = 2$ Sine $B - \frac{\text{Sine } B}{\text{Sine } B} -$ Sine $0° = 2$ Sine $\overline{B-1}$; and if A be now any Arc whatever, then Sine $\overline{A+B} = 2$ Sine $A - \frac{\text{Sine } A}{\text{Sine } B} -$ Sine $\overline{A-B}$, gives Sine $\overline{A+B} +$ Sine $\overline{A-B} = 2$ Sine $A - \frac{\text{Sine } A}{\text{Sine } B} =$ Sine $A \times \frac{2 \text{ Sine } \overline{B-1}}{\text{Sine } B} =$ Sine $A \times \frac{2 \text{ Sine } B}{\text{Sine } B} =$ Sine $A \times \frac{2 \text{ Sine } B \times \text{ Cosine } B}{\text{Sine } B} =$ 2 Sine $A \times$ Cosine B.

When the Sines of all the Pindas have been computed, the Versed Sines are easily found by subtracting the Sine of the complement from the Radius.

When Sines and Cosines only are required, the Indian Rules of Trigonometry appear very seldom to differ from those used by Europeans. But for solving those cases wherein Europeans make use of Tangents, the Indian Rule must necessarily be different, at least in appearance.

1° Let ABC be a plane Triangle, right angled at C, having an oblique angle at A, and one side given, to find the other side, the common Rule is equivalent to this proportion,



Cosine A : Sine A :: AC : CB or Sine A : Cosine A :: CB : AC.

2° If the hypothenuse be required from the same data, the Indian rule is equivalent to
Cosine A : Radius :: AC : AB or Sine A : Radius :: BC : AB.

3° If the sides be given, to find the oblique angles, they first find the hypothenuse.
$AB = \sqrt{\overline{AC}^2 + \overline{BC}^2}$, and then AB : Radius :: BC : Sine A or AB : Radius :: AC : Cosine A.

4° If the hypothenuse and a side be given, to find the other side they use $BC = \sqrt{\overline{AB}^2 - \overline{AC}^2}$.

5° As every oblique angled triangle is equal to the sum or difference of two right angled triangles, a proposition well known to the Hindus, it may be inferred that they know how to apply Trigonometry to the resolution of oblique angled plane triangles; but of this I have met no example.

There is in the French Ephemerides (Connoissance des Tems) for 1808, a curious paper on the Hindu Table of Sines by Mr. Delambre, to which I refer the reader (p. 417). He observes that if in computing the Pindas the Hindu divisor $\frac{1}{225}$ be used and the Radius at 3438′, only the three first would be correct, after which the error would increase rapidly. But if $\frac{1}{233,53}$ be employed, and Radius 3437,4 be substituted to the former, then the Hindu results would come (with a few and trifling exceptions) the same as exhibited in the preceding Table and as would result from his formula.

$$\triangle\,(^2)\ \text{Sine A} = -\,4\ \text{Sine}^2\,\tfrac{1}{2}\triangle\,\text{A Sine A} = -\,\overline{\text{Chord}}^2 \times \triangle\,\text{A} \times \text{Sine A.}\ (^*)$$

(Vide Decimal Tables, page 48.)

Mr. D. has recomputed the Hindu Trigonometrical Table on the principle that he proposes, and the only sensible differences fell on

°		Hindu Formula	French Formula.
22	30	1315	1315,56
26	15	1520	1520,59
60	0	2978	2977,47
67	30	3177	3176,30

To Radius 3437′,4.

which differences, he observes, are so trifling, that they do not affect his proposition.

(*) △ A being equal to 3° 45′.

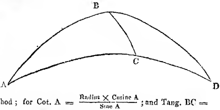
The following Problems of Hindu Spherical Trigonometry will illustrate the various cases of Gnomonics given in Part I, Article 8, page 90 and following of the 2d Memoir.

A. The modern rules make it appear that the people of India at some former period were well acquainted with the theory of Spherical Trigonometry, if they be not acquainted with it at present.

1º Let A B C be a Spherical Triangle, right angled at C, having an oblique angle at A; and a side BC given. To find the other side AC.

One of their rules is equivalent to these proportions.

First. Sine A : Sine BC :: Radius : Sine AB $= \frac{\text{Rad} \times \text{Sine BC}}{\text{Sine A}}$; and Secondly. Cosine BC : Cosine A :: Sine A B : Sine A C $= \frac{\text{Cos. A} \times \text{Sine AB}}{\text{Cosine BC}} = \frac{\text{Ra.} \times \text{Cos. A} \times \text{Sine BC}}{\text{Sine A} \times \text{Cos. BC.}}$



This answers to the European method; for Cot. A $= \frac{\text{Radius} \times \text{Cosine A}}{\text{Sine A}}$; and Tang. BC $= \frac{\text{Radius} \times \text{Sine BC}}{\text{Cosine BC}}$; so that Sine AC $= \frac{\text{Radius} \times \text{Cosine A} \times \text{Sine BC}}{\text{Sine A} \times \text{Sine BC}} = \frac{\text{Co Tang. A} \times \text{Tang. BC}}{\text{Radius}}$; which agrees with Napier's Rule.

Another Rule amounts to these proportions, viz.

First. Sine A : Cosine A :: Sine BC : Sine Z $= \frac{\text{Cosine A} \times \text{Sine BC}}{\text{Sine A}}$; and

Secondly. Cosine BC : Radius :: Sine Z : Sine AC $= \frac{\text{Radius} \times \text{Sine Z}}{\text{Cosine BC}} = \frac{\text{Radius} \times \text{Cosine A} \times \text{Sine BC}}{\text{Sine A} \times \text{Cosine BC}}$ the same as before.

When BC is a small Arc, and of course Cosine BC $=$ Radius nearly, the second proportion is omitted; and Sine AC taken equal to Sine Z $= \frac{\text{Cosine A} \times \text{Sine BC}}{\text{Sine A}}$ conformably to the rule in Plane Trigonometry.

2º If the hypothenuse and a side be given, to find the other side, they proceed as follows:

First. $\sqrt{\text{Sine}^2 \text{ AB} - \text{Sine BC}} = $ Sine Z. Secondly. Cosine BC : Radius :: Sine Z : Sine AC $= \frac{\text{Radius} \times \text{Sine Z}}{\text{Cosine BC}} = \frac{\text{Radius}}{\text{Cosine BC}} \times \sqrt{\text{Sine}^2 \text{ AB} - \text{Sine}^2 \text{ BC}}$.

This is a correct value of Sine AC; for S.^{2} AB $-$ S.^{2} BC $=$ Cosine^2 BC $-$ Cosine^2 AB; and Sine^2 AC $=$ Radius^2 $-$ Cosine^2 AC; so that Radius^2 $-$ Cosine^2 AC $= \frac{\text{Radius}^2}{\text{Cosine}^2 \text{ BC}} \times \overline{\text{Cosine}^2 \text{ BC} - \text{Cosine}^2 \text{ AB}}$ or Cosine^2 BC Radius^2 $\times$ Cosine^2 BC $-$ Cosine^2 AC $\times$ Cosine^2 BC $=$ Radius^2 $\times$ Cosine^2 BC $-$ Radius^2 $\times$ Cosine^2 AB, that is Cosine^2 AC $\times$ Cosine^2 BC $=$ Radius^2 $\times$ Cosine^2 AB; and Cosine AC $\times$ Cosine BC $=$ Radius $\times$ Cosine AB conformably to Napier's rule.

When BC is a small Arc, and Radius $=$ Cosine BC nearly, they omit the second part of the operation, and suppose Sine AC $= \sqrt{\text{Sine}^2 \text{ AB} - \text{Sine}^2 \text{ BC}}$.

3º Let ABD be an oblique angled Spherical Triangle, in which two sides AB and AD, and the included angle A are given; to find the third side BD. The method is as follows:

First. $\text{Sine AB} : \text{Cosine AB} :: \text{Cosine AD} : \text{Sine W} = \frac{\text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB}}$

Secondly. $\text{Sine AD} : \text{Sine W} :: \text{Radius} : \text{Sine X} = \frac{\text{Radius} \times \text{Sine W}}{\text{Sine AD}} = \frac{\text{Rad.} \times \text{Cos. AB} \times \text{Cos. AD}}{\text{Sine AB} \times \text{Sine AD}}$

Thirdly. $\text{Cosine A} + \text{Sine X} = \text{Sine Y} = \frac{\text{Cos. A} \times \text{Sine AB} \times \text{Sine AD} + \text{Rad.} \times \text{Cos. AB} \times \text{Cos. AD}}{\text{Sine AB} \times \text{Sine AD.}}$

Fourthly. $\text{Radius} : \text{Sine Y} :: \text{Sine AD} : \text{Sine Z} = \frac{\text{Sine Y} \times \text{Sine AD}}{\text{Radius}} =$

$$= \frac{\text{Cosine A} \times \text{Sine AB} \times \text{Sine AD} + \text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Radius} \times \text{Sine AB}}$$

Fifthly. $\text{Radius} : \text{Sine Z} :: \text{Sine AB} : \text{Cosine BD} = \frac{\text{Sine Z} \times \text{Sine AB}}{\text{Radius}} =$

$$= \frac{\text{Cosine A} \times \text{Sine AB} \times \text{Sine AD} + \text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Radius}}$$

This is a correct value of Cosine BD; but sometimes they bring out the same result in another manner, as follows:

First. Find as before $\text{Sine W} = \frac{\text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB}}$

Secondly. Find also $\text{Sine X} = \frac{\text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$

Thirdly. $\text{Radius} + \text{Sine X} = \frac{\text{Radius} \times \text{Sine AB} \times \text{Sine AD} + \text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$

Fourthly. $\text{Sine Z} - \text{Vers. Sine A} = \text{Sine Q} - \text{Radius} + \text{Cosine A} = \text{Sine Y} =$

$$= \frac{\text{Cosine A} \times \text{Sine AB} \times \text{Sine AD} + \text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$$

Lastly. Sine Z, and Cosine BD, are to be found as in the former method.

4º When the three sides of a Spherical Triangle are given, to find an angle A, the foregoing operations are reversed, as follows:

First. $\text{Sine AB} : \text{Cosine BD} :: \text{Radius} : \text{Sine Z} = \frac{\text{Radius} \times \text{Cosine BD}}{\text{Sine AB}}$

Secondly. $\text{Sine AD} : \text{Sine Z} :: \text{Radius} : \text{Sine Y} = \frac{\text{Rad.} \times \text{Sine Z}}{\text{Sine AD}} = \frac{\text{Radius}^2 \times \text{Cosine BD}}{\text{Sine AB} \times \text{Sine AD}}$

Thirdly. $\text{Sine AB} : \text{Cosine AB} :: \text{Cosine AD} : \text{Sine W} = \frac{\text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$

Fourthly. $\text{Sine AD} : \text{Sine W} :: \text{Radius} : \text{Sine X} = \frac{\text{Rad.} \times \text{Sine W}}{\text{Sine AD}}$

Fifthly. $\text{Cosine A} = \text{Sine Y} - \text{Sine X} = \frac{\text{Radius}^2 \times \text{Cosine BD} - \text{Rad. Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$

The value of Cosine A thus found is correct, and leaves scarcely any reason to doubt of the people of India being possessed of proper rules for solving all the other cases of Trigonometry, although I have not hitherto met with them.

The preceding Theorems will be found sufficient to demonstrate every case of Hindu Gnomonics, as resolved in the second Memoir of this work.

A SET OF TABLES

For facilitating the resolution of Astronomical and Gnomonic Problems, according to the theories delivered in the second Memoir.

TABLE XXXI.

For converting parts of the Equator into Indian time and vice versa.

Degrees into Time.						Time into Degrees.								
° ′ ″	G. V. P.	V. P. S.	° ′ ″	G. V. P.	V. P. S.	Vigud. Paras. Suras.	° ′ ″	′ ″ ″	Vig. Par. Sur.	° ′ ″	Guddias.	°	Guddias.	°
1	0	10	10	1	40	1	0	6	10	1	1	6	10	60
2	0	20	20	3	20	2	0	12	20	2	2	12	20	120
3	0	30	30	5	0	3	0	18	30	3	3	18	30	180
4	0	40	40	6	40	4	0	24	40	4	4	24	40	240
5	0	50	50	8	20	5	0	30	50	5	5	30	50	300
6	0	60	60	10	0	6	0	36	60	6	6	36	60	360
7	1	10	120	20	0	7	0	42			7	42		
8	1	20	180	30	0	8	0	48			8	48		
9	1	30	240	40	0	9	0	54			9	54		
10	1	40	300	50	0	10	1	0			10	60		
			360	60	0									

TABLE XXXII.

Shewing the Sun's Declination, Right Ascension and Amplitude, when his Longitude is I, II *and* III *Signs; which quantities are constant, and applicable to all places.*

Signs.	Sun's Longitude.	Sines.	Sun's Declination.		Sines.	Lagna.	Agra.		Sines.
		′	°	′	′	′	°	′	′
I	Yekajya or Sine of 30°	1719	11	43	693	1670	12	1	716
II	Duojaya do. of 60	2978	20	38	1211	1795	21	12	1243
III	Trijaya do. of 90	3438	20	0	1397	1935	24	40	1434

The Chara Cumda, and Ullagna, are to be calculated for the specific place computed for.

TABLE XXXIII.

Exhibiting the Latitudes and Longitudes of certain principal places in India, referred to the Rec'ha or Meridian of Lanca, such as found in some of the Indian Ephemerides annexed to the Solar and Luni-solar Patras, or Kalendars; the circumference of the Equatorial Circle being = 5059,3 *yojanas.*

Names of Places.	Latitudes or Acsha Bagahs.			Longitude or Desentara.								
				In Degrees.				In Time.				In Yojanas
	°	′	″	°	′	″		G.	V.	P.	S.	
Delhi - -	27	35	0 N	1	16	8	E	+0	13	0	0	17
Benares - -	25	38	0	4	37	0	E	0	46	10	0	64
Oogein - -	23	11	30	0	0	0		0	0	0	0	0
Calcutta - -	22	34	45	12	36	30	E	2	6	5	0	177
Ganjam - -	19	22	0	9	17	0	E	1	33	0	0	130
Bombay - -	18	46	40	3	15	0	W	—0	32	30	0	— 46
Poona - -	18	30	0	1	41	0	W	0	17	0	0	— 24
Chicacole - -	18	12	0	8	7	0	E	+1	22	0	0	114
Vizagapatam -	17	42	0	7	32	45	E	1	15	27	30	106
Hyderabad (Golconda) -	17	26	51	2	58	45	E	0	29	47	30	42
Anagoondy - -	16	30	0	0	0	0		0	0	0	0	0
Banda near Masulipatam	16	15	0	5	19	45	E	0	53	17	30	75
Calastri - -	13	58	0	4	8	0	E	0	41	0	0	58
Madras - -	13	4	12	4	35	45	E	0	45	57	0	65
Bangalore - -	12	56	49	1	42	18	E	0	17	3	0	24
Mangalore - -	12	51	38	1	0	12	W	—0	10	2	0	— 14
Conjevaram - -	12	51	0	3	59	0	E	+0	40	0	0	56
Seringapatam - -	12	32	0	0	58	45	E	0	9	47	30	14
Pondicherry - -	11	55	56	4	0	33	E	0	40	5	30	56
Tanjore - -	10	47	0	3	18	9	E	0	33	1	30	47
Trivalore - -	10	44	0	3	32	58	E	0	35	29	44	49
Madura - -	9	54	0	2	25	0	E	0	24	0	0	34
Ramissuram - -	9	18	7	3	28	50	E	0	34	48	45	49
Anantachyam (Travancore)	8	26	0	1	22	0	E	0	14	0	0	19

To have the Longitude of any place expressed in yojanas, say, as 360°, to 5059,3, so the given Longitude in degrees, to the distance from the first Meridian counted on the Equator, in yojanas.

N. B.—For fine computations the parts of yojanas either in sexagesimals or decimals must be accounted for.

EXAMPLE I.

The Longitude of Benares in degrees being 4° 37′. Say 360° : 5059,3 :: 4° 37′ : $\frac{5059,3 \times 4° \; 37'}{360}$ = 64,88 yojanas.

EXAMPLE II.

The Longitude of Trivalore in degrees being 3° 32′ 58″. Say 360° : 5059,3 :: 3° 32′ 58″ : $\frac{5059,3 \times 3° \; 32' \; 58''}{360}$ = 49,88 yojanas.

TABLE XXXIV.

Exhibiting the Palabah, or Vishama Chaya, *the Shadow of the Gnomon at noon on the days of the Equinoxes, and the circumference of the Circle of Longitude called* Seva-desa Paridhi, *at some of the principal places in India,—the Equatorial Circle being taken to contain* 5059,3 *yojanas.*

Names of Places.	Polar Altitude.		Sines.	Cosines.	Palabah.		Seva-desa Paridhi. Circumference of Circle of Longitude.
					A.	V.	
Benares - -	25°	38	1487',0	3101',9	5	45,1	4564',7
Oogein - -	23	12	1352,3	3160,7	5	8,0	4651,2
Calcutta - -	22	35	1319,5	3175,0	4	59,9	4672,1
Bombay - -	18	47	1106,8	3255,3	4	4,7	4790,4
Vizagapatam - -	17	42	1042,8	3274,9	3	49,2	4819,3
Hyderabad - -	17	27	1030,4	3278,6	3	44,4	4824,7
Banda (near Masulipatam)	16	15	961,6	3299,4	3	29,8	4855,3
Madras - -	13	4	776,2	3347,4	2	46,8	4925,9
Bangalore - -	12	57	770,2	3348,9	2	45,5	4928,2
Mangalore - -	12	52	765,4	3350,1	2	44,4	4929,8
Seringapatam - -	12	32	745,9	3354,6	2	40,0	4936,5
Pondicherry - -	11	57	711,3	3362,7	2	32,2	4948,4
Tanjore - -	10	47	643,3	3376,7	2	17,1	4969,1
Trivalore - -	10	44	640,4	3377,1	2	15,5	4969,6
Ramissuram - -	9	18	555,5	3391,8	1	57,9	4991,3

By help of this Table the *Lagna, Chura Cumda,* and *Ullagna* of any place therein registered, may be readily computed.

For finding the difference of Longitude in time under any parallel of Latitude, say: As circumference of Circle of Longitude at that place, to 60 guddias, (or dandas), so the Longitude in yojanas counted on the Equatorial Circle, to the difference of Longitude in time of the place computed for.

EXAMPLE I.

For Benares, the Longitude of which is 64,88 yojanas East of Lanca.

Table IV. $4564{,}7 : 60^{g} :: 64{,}88$ &c. : $\frac{60 \times 64{,}88}{4564{,}7} = 0^{g}\ 51^{v}\ 10^{p}\ 5^{v}$.

EXAMPLE II.

For Trivalore, its Longitude in yojanas being 49,88 &c.

$4969{,}6 : 60^{g} :: 49{,}88$ &c. : $\frac{60 \times 49{,}88 \text{ \&c.}}{4969{,}6} = 0^{g}\ 36^{v}\ 8^{p}\ 24^{v}$.

TABLE XXXV.

Shewing the Ayananse for Secular years, from A. D. 0, to the Julian year 2000, concurrent with the years Cali yugam 3101, and 5101 ; or 78 years before and 1922 after the birth of Salivahana ; giving at the same time the Sun's Ravi Sayana or Longitude at the commencement of each Secular Sydereal year.

Date in March O. S.	Julian Secular years.	Years expired of the Æra Cali yug.	Ayanansa.			Longitude.				Date in April N S
			Second Padah.							
			°	′	″	s	°	′	″	
14	0	3101	—7	29	6	11	22	30	54	
14	100	3201	5	59	6	11	24	0	54	
15	200	3301	4	29	6	11	25	30	54	
16	300	3401	2	59	6	11	27	0	54	
17	400	3501	1	29	6	11	28	30	54	
18	499	3600	0	0	0	0	0	0	0	
			Third Padah. (*)							
18	500	3601	+0	0	54	In this Padah the Ayanansa is additive and follows the order of the Zodiacal Signs.				
19	600	3701	1	30	54					
20	700	3801	3	0	54					
20	800	3901	4	30	54					
21	900	4001	6	0	54					
22	1000	4101	7	30	54					
23	1100	4201	9	0	54					
24	1200	4301	10	30	54					
25	1300	4401	12	0	54					
26	1400	4501	13	30	54					
27	1500	4601	15	0	54					5
27	1600	4701	16	30	54					6
28	1700	4801	18	0	54					8
29	1800	4901	19	30	54					10
30	1900	5001	21	0	54					12
31	2000	5101	22	30	54					13

Table for finding the Ayanansa for odd years.

Y.	′	″	Y.	°	′
1	0	54	70	1	3
2	1	48	80	1	12
3	2	42	90	1	21
4	3	36	100	1	30
5	4	30	200	3	0
6	5	24	300	4	30
7	6	18	400	6	0
8	7	12	500	7	30
9	8	6	600	9	0
10	9	0	700	10	30
20	18	0	800	12	0
30	27	0	900	13	30
40	36	0	1000	15	0
50	45	0			
60	54	0			

As only the Secular years are given in the first part of this Table, in order to find for what European date in odd years of the centuries the Ayanansa is computed, the beginning of the corresponding Hindu Solar year must be sought by means of Tables I and VII.

EXAMPLE.

How to find the Ayanansa for the year Cali yugam 4846 complete, corresponding to A. D. 1745, on Friday the 9th April N. S.

Cali yug.	A. D.	°	′	″	‴
4801	1700	18	0	54	
40	40		36	0	
5	5		4	30	
4846	1745	18	41	24	0
By the Siddhanta Rule		18	41	23	11
		Difference			49

(*) In the 3d Quadrant of the Ayanansa, the quantities given in the 4th column shew both the Ayanansa and the Longitude of the 1st point in Mesha ♈ at the beginning of the year.

TABLE XXXVI.

Being auxiliary to the XXXVth, for finding the error of the Sun's mean Longitude as computed in the Hindu Solar Tables, when referred to the European Tables.

Julian Secular years.	Years expired since the Epoch Cali yug.	Ayanansa, the Cranti Patagati being supposed 54″ 1‴ 15⁗.							
		Second Padah.							
		°	′	″	‴	s.	°	′	″
0	3101	7	29	16	19	11	22	30	47
100	3201	5	59	14	15	11	24	0	45
200	3301	4	29	12	11	11	25	30	47
300	3401	2	59	10	7	11	27	0	49
400	3501	1	29	8	3	11	28	30	51
	3600	0	0	0	0	0	0	0	0
		Third Padah.							
500	3601		+	54	1				
600	3701	1	30	56	6				
700	3801	3	0	58	11				
800	3901	4	31	0	16				
900	4001	6	1	2	21				
1000	4101	7	31	4	26				
1100	4201	9	1	6	31				
1200	4301	10	31	8	36				
1300	4401	12	1	10	41				
1400	4501	13	31	12	46				
1500	4601	15	1	14	51				
1600	4701	16	31	16	56				
1700	4801	18	1	19	1				
1800	4901	19	31	21	6				
1900	5001	21	1	23	11				
2000	5101	22	31	25	16				

Table for finding the Ayanansa for odd years.										
	′	″	‴	⁗		°	′	″	‴	⁗
1	0	54	1	15	70	1	3	1	26	30
2	1	48	2	30	80	1	12	1	39	0
3	2	42	3	45	90	1	21	1	51	30
4	3	36	5	0	100	1	30	2	4	0
5	4	30	6	15	200	3	0	4	10	0
6	5	24	7	30	300	4	30	6	15	0
7	6	18	8	45	400	6	0	8	20	0
8	7	12	10	0	500	7	30	10	25	0
9	8	6	11	15	600	9	0	12	30	0
10	9	0	12	30	700	10	30	14	35	0
20	18	0	24	0	800	12	0	16	40	0
30	27	0	36	30	900	13	30	18	45	0
40	36	0	49	0	1000	15	0	20	50	0
50	45	1	1	30						
60	54	1	15	0						

Table XXXV is to Table XXXVI

In the constant ratio of $\frac{54''}{54'' \; 1''' \; 15''''} = x$;

vide Appendix II.

TIDHI TABLE XXXVII.

Index.	Equation.		Diurnal motion.		Index.	Equation.		Diurnal motion.		Index.	Equation.		Diurnal motion.		Index.	Equation.		Diurnal motion.	
1	2	4	11	2	22	24	29	12	25	43	1	43	13	20	64	24	49	12	10
2	4	7	11	3	23	24	7	12	30	44	3	25	13	20	65	24	48	12	5
3	6	8	11	5	24	23	37	12	35	45	5	6	13	19	66	24	38	12	0
4	8	6	11	7	25	23	1	12	40	46	6	45	13	18	67	24	18	11	55
5	9	59	11	9	26	22	17	12	44	47	8	23	13	16	68	23	51	11	50
6	11	49	11	12	27	21	27	12	48	48	9	58	13	14	69	23	15	11	45
7	13	33	11	15	28	20	30	12	52	49	11	31	13	12	70	22	30	11	40
8	15	12	11	18	29	19	27	12	56	50	13	0	13	9	71	21	37	11	35
9	16	43	11	22	30	18	19	13	0	51	14	26	13	6	72	20	35	11	30
10	18	8	11	26	31	17	6	13	3	52	15	43	13	3	73	19	25	11	26
11	19	25	11	30	32	15	48	13	6	53	17	6	13	0	74	18	8	11	22
12	20	35	11	35	33	14	26	13	9	54	18	19	12	56	75	16	43	11	18
13	21	37	11	40	34	13	0	13	12	55	19	27	12	52	76	15	12	11	15
14	22	30	11	45	35	11	31	13	14	56	20	30	12	48	77	13	33	11	12
15	23	15	11	50	36	9	58	13	16	57	21	27	12	44	78	11	49	11	9
16	23	51	11	55	37	8	23	13	18	58	22	17	12	40	79	9	59	11	7
17	24	18	12	0	38	6	45	13	19	59	23	1	12	35	80	8	6	11	5
18	24	38	12	5	39	5	6	13	20	60	23	37	12	30	81	6	5	11	3
19	24	48	12	10	40	3	25	13	20	61	24	37	12	25	82	4	7	11	2
20	24	49	12	15	41	1	43	13	21	62	24	29	12	20	83	2	4	11	2
21	24	43	12	20	42	0	0	13	21	63	24	43	12	15	84	0	0	11	2

NACSHATRA TABLE XXXVIII.

Index.	Equation.		Index.	Equation.		Index.	Equation.		Index.	Equation.		Index.	Equation.		Index.	Equation.		Index.	Equation.	
1	2	0	13	20	29	25	20	29	37	4	58	49	14	1	61	22	58	73	13	0
2	3	53	14	21	16	26	19	39	38	3	20	50	15	18	62	22	56	74	11	22
3	5	54	15	21	5[illegible]	27	18	42	39	1	40	51	16	31	63	22	4[illegible]	75	9	36
4	7	47	16	22	22	28	17	39	40	0	0	52	17	39	64	22	22	76	7	47
5	9	36	17	22	43	29	16	31	41	1	40	53	18	44	65	21	53	77	5	54
6	11	21	18	22	55	30	15	18	42	3	20	54	19	39	66	21	16	78	3	53
7	13	0	19	22	53	31	14	1	43	4	58	55	20	29	67	20	20	79	2	0
8	14	33	20	22	53	32	12	35	44	6	35	56	21	13	68	19	33	80	0	0
9	15	59	21	22	39	33	11	12	45	8	10	57	21	49	69	18	30			
10	17	19	22	22	18	34	9	42	46	9	42	58	22	18	70	17	19			
11	18	30	23	21	49	35	8	10	47	11	12	59	22	31	71	15	59			
12	19	33	24	21	13	36	6	35	48	12	39	60	22	53	72	14	53			

YOGA TABLE XXXIX.

Index.	Equation.		Diurnal motion.		Index.	Equation.		Diurnal motion.		Index.	Equation.		Diurnal motion.		Index.	Equation.		Diurnal motion.	
1	1	43	13	0	23	21	0	14	25	45	2	54	15	18	67	21	16	14	0
2	3	25	13	1	24	20	40	14	30	46	4	20	15	17	68	21	3	13	55
3	5	5	13	3	25	20	13	14	34	47	5	45	15	16	69	20	43	13	50
4	6	43	13	5	26	19	40	14	39	48	7	8	15	14	70	20	16	13	45
5	8	18	13	7	27	19	2	14	43	49	8	20	15	12	71	19	42	13	40
6	9	50	13	9	28	18	18	14	47	50	9	48	15	10	72	19	1	13	35
7	11	18	13	12	29	17	29	14	51	51	11	4	15	8	73	18	13	13	31
8	12	41	13	15	30	16	35	14	55	52	12	12	15	5	74	17	19	13	27
9	13	59	13	19	31	15	37	14	59	53	13	28	15	2	75	16	18	13	23
10	15	11	13	23	32	14	34	15	2	54	14	34	14	59	76	15	11	13	19
11	16	18	13	27	33	13	23	15	5	55	15	37	14	55	77	13	59	13	15
12	17	19	13	31	34	12	18	15	8	56	16	35	14	51	78	12	41	13	12
13	18	13	13	35	35	11	44	15	10	57	17	29	14	47	79	11	18	13	9
14	19	1	13	40	36	9	48	15	12	58	18	18	14	43	80	9	50	13	7
15	19	42	13	45	37	9	29	15	14	59	19	2	14	39	81	8	18	13	5
16	20	16	13	50	38	7	8	15	16	60	19	40	14	34	82	6	43	13	3
17	20	43	13	55	39	5	45	15	17	61	20	13	14	30	83	5	5	13	1
18	21	3	14	0	40	4	20	15	18	62	20	40	14	25	84	3	25	13	0
19	21	16	14	5	41	2	54	15	19	63	21	0	14	20	85	1	43	13	0
20	21	22	14	10	42	1	27	15	19	64	21	14	14	15	86	0	0	13	0
21	21	21	14	15	43	0	0	15	19	65	21	21	14	10					
22	21	14	14	20	44	1	27	15	19	66	21	22	14	5					

SOLAR TABLE XL.

Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.
1	0 2 16	13 41	44	1 29 10	13 51	87	2 9 52	14 33	130	1 45 52	15 27
2	0 4 31	13 41	45	1 30 46	13 51	88	2 10 4	14 35	131	1 44 35	15 28
3	0 6 47	13 41	46	1 32 21	13 52	89	2 10 14	14 36	132	1 43 15	15 30
4	0 9 2	13 40	47	1 33 53	13 53	90	2 10 20	14 37	133	1 41 52	15 31
5	0 11 17	13 40	48	1 35 23	13 54	91	2 10 21	14 38	134	1 40 29	15 32
6	0 13 32	13 40	49	1 36 53	13 55	92	2 10 23	14 39	135	1 39 5	15 33
7	0 15 47	13 39	50	1 38 23	13 56	93	2 10 30	14 41	136	1 37 37	15 35
8	0 18 1	13 39	51	1 39 48	13 57	94	2 10 26	14 42	137	1 36 7	15 36
9	0 20 14	13 39	52	1 41 11	13 57	95	2 10 22	14 44	138	1 34 37	15 37
10	0 22 27	13 39	53	1 42 33	13 58	96	2 10 17	14 44	139	1 33 7	15 38
11	0 24 39	13 39	54	1 43 53	13 59	97	2 10 10	14 45	140	1 31 33	15 39
12	0 26 51	13 39	55	1 45 13	14 0	98	2 9 53	14 47	141	1 29 57	15 41
13	0 29 2	13 39	56	1 46 30	14 1	99	2 9 45	14 48	142	1 28 21	15 42
14	0 31 13	13 39	57	1 47 46	14 2	100	2 9 31	14 49	143	1 26 44	15 43
15	0 33 23	13 39	58	1 49 1	14 3	101	2 9 14	14 51	144	1 25 4	15 44
16	0 35 33	13 39	59	1 50 11	14 4	102	2 8 54	14 52	145	1 23 22	15 45
17	0 37 41	13 39	60	1 51 21	14 4	103	2 8 34	14 53	146	1 21 40	15 46
18	0 39 49	13 39	61	1 52 29	14 5	104	2 8 11	14 54	147	1 19 56	15 47
19	0 41 56	13 39	62	1 53 35	14 6	105	2 7 46	14 55	148	1 18 10	15 49
20	0 44 2	13 40	63	1 54 38	14 7	106	2 7 16	14 57	149	1 16 23	15 50
21	0 46 7	13 40	64	1 55 38	14 8	107	2 6 46	14 58	150	1 14 35	15 51
22	0 48 12	13 40	65	1 56 38	14 9	108	2 6 16	14 59	151	1 12 45	15 52
23	0 50 16	13 40	66	1 57 38	14 10	109	2 5 41	15 0	152	1 10 58	15 53
24	0 52 19	13 40	67	1 58 33	14 11	110	2 5 4	15 2	153	1 9 1	15 54
25	0 54 21	13 40	68	1 59 27	14 12	111	2 4 27	15 3	154	1 7 8	15 55
26	0 56 21	13 41	69	2 0 20	14 13	112	2 3 47	15 4	155	1 5 14	15 56
27	0 58 21	13 41	70	2 1 10	14 14	113	2 3 4	15 6	156	1 3 17	15 57
28	1 0 21	13 41	71	2 1 57	14 15	114	2 2 19	15 7	157	1 1 19	15 58
29	1 2 19	13 42	72	2 2 42	14 16	115	2 1 38	15 8	158	0 59 21	16 0
30	1 4 16	13 42	73	2 3 26	14 18	116	2 0 46	15 9	159	0 57 21	16 0
31	1 6 12	13 43	74	2 4 6	14 19	117	1 59 53	15 11	160	0 55 21	16 2
32	1 8 5	13 43	75	2 4 46	14 20	118	1 58 59	15 12	161	0 53 19	16 2
33	1 9 58	13 44	76	2 5 23	14 21	119	1 58 5	15 13	162	0 51 17	16 3
34	1 11 50	13 44	77	2 5 59	14 22	120	1 57 9	15 15	163	0 49 14	16 4
35	1 13 40	13 45	78	2 6 31	14 23	121	1 56 9	15 16	164	0 47 10	16 5
36	1 15 30	13 45	79	2 7 1	14 24	122	1 55 9	15 17	165	0 45 5	16 6
37	1 17 17	13 46	80	2 7 31	14 25	123	1 54 7	15 18	166	0 42 59	16 7
38	1 19 4	13 47	81	2 8 1	14 26	124	1 53 4	15 20	167	0 40 52	16 7
39	1 20 49	13 47	82	2 8 24	14 28	125	1 51 54	15 21	168	0 38 45	16 8
40	1 22 32	13 48	83	2 8 44	14 29	126	1 50 44	15 22	169	0 36 37	16 9
41	1 24 14	13 49	84	2 9 4	14 30	127	1 49 34	15 22	170	0 34 28	16 10
42	1 25 54	13 49	85	2 9 21	14 31	128	1 48 24	15 24	171	0 32 18	16 11
43	1 27 34	13 50	86	2 9 39	14 32	129	1 47 9	15 26	172	0 30 8	16 11

SOLAR TABLE, *continued.*

Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.
173	0 27 57	16 12	216	1 5 14	16 19	259	2 3 47	15 47	302	2 0 20	14 55
174	0 25 45	16 13	217	1 7 8	16 19	260	2 4 27	15 46	303	1 59 27	14 53
175	0 23 33	16 14	218	1 9 1	16 18	261	2 5 4	15 45	304	1 58 33	14 52
176	0 21 20	16 14	219	1 10 53	16 18	262	2 5 41	15 44	305	1 57 38	14 51
177	0 19 7	16 14	220	1 12 45	16 17	263	2 6 16	15 43	306	1 56 38	14 49
178	0 16 54	16 15	221	1 14 35	16 17	264	2 6 46	15 42	307	1 55 38	14 48
179	0 14 40	16 16	222	1 16 23	16 16	265	2 7 16	15 41	308	1 54 38	14 47
180	0 12 25	16 16	223	1 18 10	16 16	266	2 7 46	15 39	309	1 53 36	14 45
181	0 10 10	16 17	224	1 19 56	16 15	267	2 8 11	15 38	310	1 52 29	14 44
182	0 7 55	16 17	225	1 21 40	16 14	268	2 8 34	15 37	311	1 51 21	14 43
183	0 5 40	16 17	226	1 23 22	16 14	269	2 8 54	15 36	312	1 50 11	14 41
184	0 3 24	16 18	227	1 25 4	16 13	270	2 9 14	15 35	313	1 49 1	14 40
185	0 1 8	16 18	228	1 25 44	16 13	271	2 9 31	15 34	314	1 47 46	14 39
186	0 1 8	16 19	229	1 28 21	16 12	272	2 9 45	15 33	315	1 46 30	14 37
187	0 3 24	16 19	230	1 29 57	16 12	273	2 9 58	15 31	316	1 45 13	14 36
188	0 5 40	16 20	231	1 31 33	16 11	274	2 10 10	15 30	317	1 43 53	14 35
189	0 7 55	16 20	232	1 33 7	16 10	275	2 10 17	15 29	318	1 42 33	14 33
190	0 10 10	16 20	233	1 34 37	16 10	276	2 10 22	15 28	319	1 41 11	14 32
191	0 12 25	16 20	234	1 36 7	16 10	277	2 10 26	15 26	320	1 39 48	14 31
192	0 14 40	16 20	235	1 37 37	16 8	278	2 10 30	15 25	321	1 38 23	14 30
193	0 16 54	16 21	236	1 39 5	16 8	279	2 10 28	15 24	322	1 36 53	14 28
194	0 19 7	16 21	237	1 40 29	16 7	280	2 10 24	15 23	323	1 35 23	14 27
195	0 21 20	16 21	238	1 41 52	16 6	281	2 10 20	15 22	324	1 33 53	14 26
196	0 23 33	16 21	239	1 43 15	16 5	282	2 10 14	15 21	325	1 32 21	14 24
197	0 25 45	16 21	240	1 44 35	16 4	283	2 10 4	15 19	326	1 30 46	14 23
198	0 27 57	16 22	241	1 45 52	16 4	284	2 9 52	15 18	327	1 29 10	14 22
199	0 30 8	16 22	242	1 47 9	16 3	285	2 9 39	15 17	328	1 27 34	14 20
200	0 32 18	16 22	243	1 48 24	16 1	286	2 9 24	15 15	329	1 25 54	14 19
201	0 34 28	16 22	244	1 49 34	16 1	287	2 9 4	15 14	330	1 24 14	14 18
202	0 36 37	16 22	245	1 50 44	16 0	288	2 8 44	15 13	331	1 22 32	14 17
203	0 38 45	16 22	246	1 51 54	15 59	289	2 8 24	15 12	332	1 20 49	14 16
204	0 40 52	16 22	247	1 53 4	15 58	290	2 8 1	15 10	333	1 19 4	14 14
205	0 42 59	16 22	248	1 54 7	15 58	291	2 7 31	15 9	334	1 17 17	14 13
206	0 45 5	16 22	249	1 55 9	15 57	292	2 7 1	15 8	335	1 15 30	14 12
207	0 47 10	16 21	250	1 56 9	15 56	293	2 6 31	15 7	336	1 13 40	14 11
208	0 49 14	16 21	251	1 57 9	15 55	294	2 5 59	15 6	337	1 11 50	14 10
209	0 51 17	16 21	252	1 58 5	15 54	295	2 5 23	15 4	338	1 9 58	14 8
210	0 53 19	16 21	253	1 58 59	15 53	296	2 4 46	15 3	339	1 8 5	14 7
211	0 55 21	16 20	254	1 59 53	15 53	297	2 4 6	15 1	340	1 6 12	14 6
212	0 57 21	16 20	255	2 0 46	15 51	298	2 3 26	15 0	341	1 4 16	14 5
213	0 59 21	16 20	256	2 1 33	15 50	299	2 2 42	14 59	342	1 2 19	14 4
214	1 1 19	16 20	257	2 2 19	15 49	300	2 1 57	14 58	343	1 0 21	14 3
215	1 3 17	16 19	258	2 3 4	15 48	301	2 1 10	14 56	344	0 53 21	14 2

SOLAR TABLE, *continued.*

Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.	Index.	Equation.	½ Diurnal Arc.
345	0 56 21	14 1	353	0 39 49	13 54	361	0 22 27	13 46	369	0 4 31	13 43
346	0 54 21	14 0	354	0 37 41	13 52	362	0 20 14	13 46	370	0 2 16	13 42
347	0 52 19	13 59	355	0 35 33	13 51	363	0 18 1	13 45	371	0 0 0	13 41
348	0 50 16	13 58	356	0 33 23	13 50	364	0 15 47	13 45			
349	0 48 12	13 57	357	0 31 13	13 50	365	0 13 32	13 44			
350	0 46 7	13 56	358	0 29 2	13 49	366	0 11 17	13 44			
351	0 44 2	13 55	359	0 26 51	13 48	367	0 9 2	13 43			
352	0 41 56	13 54	360	0 24 39	13 47	368	0 6 43	13 43			

TABLE XLI.

♂ I.

Of the mean motion of Mars, for days.

Days.	Mean motion.					Days.	Mean motion.				
	s.	°	′	″	‴		s.	°	′	″	‴
1	0	0	31	26	28	1000	5	14	1	9	46
2	0	0	2	52	56	2000	10	28	2	19	32
3	0	1	34	19	25	3000	4	12	3	29	17
4	0	2	5	45	53	4000	9	26	4	39	3
5	0	2	37	12	21	5000	3	10	5	48	49
6	0	3	8	38	49	6000	8	24	6	58	35
7	0	3	40	5	17	7000	2	8	8	8	21
8	0	4	11	31	45	8000	7	22	9	18	7
9	0	4	42	58	14	9000	1	6	10	27	52
10	0	5	14	24	42	10000	6	20	11	37	38
20	0	10	23	49	24	20000	1	10	23	15	16
30	0	15	43	14	6	30000	8	0	34	52	54
40	0	20	57	38	47	40000	2	20	46	30	33
50	0	26	12	3	29	50000	9	10	58	8	11
60	1	1	26	28	11	60000	4	1	9	45	49
70	1	6	40	52	53	70000	10	21	21	23	27
80	1	11	55	17	35	80000	5	11	33	1	5
90	1	17	9	42	17	90000	0	1	44	38	44
100	1	22	24	6	59	100000	6	21	56	16	22
200	3	14	48	13	57	200000	1	13	52	32	43
300	5	7	12	20	56	300000	8	5	48	49	5
400	6	29	36	27	54	400000	2	27	45	5	27
500	8	22	0	34	53	500000	9	19	41	21	49
600	10	14	24	41	51	600000	4	11	37	38	10
700	0	6	48	48	50	700000	11	3	33	54	32
800	1	29	12	55	49	800000	5	25	30	10	54
900	3	21	37	2	47	900000	0	17	26	27	16
1000	5	14	1	9	46	1000000	7	9	22	43	27

Drura 9^{s} 22° 35′ 28″.

Epoch for all the Tables A. Cali yug 4390 complete,

♂ II.

MANGALA P'HALA.

Sup. Mean Anomaly.

°	′	+ 0^s — VI^s			+ I^s — VII^s			+ II^s — VIII^s			°	′
		s	°	′	s	°	′	s	°	′		
0	0	0	0	0	5	51	32	10	1	57	30	0
3	45	0	46	45	6	29	48	10	22	45	26	15
7	30	1	33	3	7	6	19	10	40	57	22	30
11	15	2	18	42	7	40	59	10	56	24	18	45
15	0	3	3	30	8	13	43	11	9	4	15	0
18	45	3	47	15	8	41	20	11	19	3	11	15
22	30	4	29	58	9	12	40	11	26	21	7	30
26	15	5	11	27	9	38	32	11	30	41	3	45
30	0	5	51	32	10	1	57	11	32	3	0	0
°	′	— XI^s + V^s			— X^s + IV^s			— IX^s + III^s			°	′

Sup. Mean Anomaly.

The Argument of this Table is found by subtracting Mars' corrected mean place from that of his Apsis.

* * *

TABLE *of* MARS' ANNUAL EQUATION, *and* CHILA CARNA. (*). *The Argument of this Table is found by subtracting Mars' mean place corrected, from the Sun's mean place.*

♂ III.

Commutation.

		+ 0^s				+ I^s				+ II^s				+ III^s				+ IV^s				+ V^s					
°	′	Equation			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	°	′
		°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′		
0	0	0	0	0	5682	11	43	45	5484	22	55	58	4937	32	48	11	4090	39	34	8	3019	36	31	22	1874	30	0
3	45	1	28	52	5678	13	10	20	5431	24	16	17	4846	33	52	0	3966	39	58	8	2875	34	30	1	1743	26	15
7	30	2	57	16	5667	14	35	52	5379	25	34	26	4751	34	54	22	3839	40	13	17	2730	31	53	1	1618	22	30
11	15	4	26	0	5651	16	1	25	5318	26	51	22	4651	35	53	42	3708	40	17	36	2585	28	33	6	1503	18	45
15	0	5	54	15	5629	17	26	0	5252	28	6	40	4547	36	47	32	3575	40	9	2	2440	24	24	37	1402	15	0
18	45	7	21	54	5601	18	49	23	5181	29	19	44	4429	37	37	7	3440	39	45	49	2295	19	23	2	1317	11	15
22	30	8	49	32	5567	20	13	7	5104	30	31	32	4327	38	22	24	3303	39	4	13	2152	13	30	28	1251	7	30
26	15	10	16	45	5528	21	35	5	5023	31	41	54	4210	39	1	41	3162	38	0	7	2011	6	58	6	1209	3	45
30	0	12	43	45	5484	22	55	58	4937	32	48	11	4090	39	34	8	3019	36	31	22	1874	0	0	0	1194	0	0
°	′	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	°	′
		— XI^s				— X^s				— IX^s				— VIII^s				— VII^s				— VI^s					

Commutation.

(*) Chila Carna means the true distance of a Planet from the Earth, in contradistinction to its *mean* distance, or radius of the Deferent.

TABLE XLII.

☿ I.

Of the mean motion of Mercury, for days.

Days.	Mean motion.					Days.	Mean motion.				
	s.	°	′	″	‴		s.	°	′	″	‴
1	0	4	5	32	21	1000	4	12	19	4	58
2	0	8	11	4	41	2000	8	24	38	9	56
3	0	12	16	37	2	3000	1	6	57	14	53
4	0	16	22	9	23	4000	5	19	16	19	50
5	0	20	27	41	43	5000	10	1	35	24	48
6	0	24	33	14	4	6000	2	13	54	29	45
7	0	28	38	46	25	7000	6	26	13	34	43
8	1	2	44	18	46	8000	11	8	32	39	41
9	1	6	49	51	6	9000	3	20	51	44	38
10	1	10	55	23	27	10000	8	3	10	49	36
20	2	21	50	46	54	20000	4	6	21	39	12
30	4	2	46	10	21	30000	0	9	32	28	47
40	5	13	41	33	48	40000	8	12	43	18	23
50	6	24	36	57	15	50000	4	15	54	7	59
60	8	5	32	20	42	60000	0	19	4	57	35
70	9	16	27	44	9	70000	8	22	15	47	10
80	10	27	23	7	36	80000	4	25	26	36	46
90	0	8	18	31	3	90000	0	28	37	26	22
100	1	19	13	54	30	100000	9	1	48	15	58
200	3	8	27	49	0	200000	6	3	36	31	55
300	4	27	41	43	29	300000	3	5	24	47	53
400	6	16	55	37	59	400000	0	7	13	3	50
500	8	6	9	32	29	500000	9	9	1	19	48
600	9	25	23	26	59	600000	6	10	49	35	46
700	11	14	37	21	28	700000	3	12	37	51	43
800	1	3	51	15	58	800000	0	14	26	7	41
900	2	23	5	10	28	900000	9	16	14	23	38
1000	4	12	19	4	58	1000000	6	18	2	39	36

Druva 10ˢ 26° 48′,9″.

☿ II.

BHUDA P'HALA.

Sup. mean Anomaly.													
°	'	+ 0s — VIs			+ Is — VIIs			+ IIs — VIIIs			°	'
0	0	0	0	0	2	18	23	3	53	53	30	0
3	45	0	18	40	2	33	16	4	1	42	26	15
7	30	0	37	6	2	47	21	4	8	32	22	30
11	15	0	55	11	3	0	38	4	11	17	18	45
15	0	1	12	53	3	13	1	4	19	4	15	0
18	45	1	30	7	3	24	39	4	22	45	11	15
22	30	1	46	47	3	35	20	4	25	29	7	30
26	15	2	2	56	3	45	5	4	27	2	3	45
30	0	2	18	28	3	53	53	4	27	35	0	0
°	'	— XIs + Vs			— Xs + IVs			— IXs + IIIs			°	'
Sup. mean Anomaly.												

The Argument of this Table is found by subtracting the Sun's place corrected by certain Equations from the place of Mercury's Apsis.

TABLE *of* MERCURY'S ANNUAL EQUATION, *and* CHILA CARNA. *The Argument of this Table is found by subtracting the Sun's mean place corrected, from Mercury's mean place corrected.*

☿ III.

Commutation.																										
		+ 0s				+ Is				+ IIs				+ IIIs				+ IVs				+ Vs					
°	'	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	°	'
		°	'	"	'	°	'	"	'	°	'	"	'	°	'	"	'	°	'	"	'	°	'	"	'		
0	0	0	0	0	4708	7	56	29	4578	15	2	1	4213	20	9	10	3662	21	17	39	3012	15	6	57	2426	30	0
3	45	1	0	42	4706	8	53	4	4545	15	49	2	4153	20	34	13	3584	21	0	9	2930	13	39	49	2370	26	15
7	30	2	1	15	4699	9	49	56	4507	16	33	55	4090	20	55	12	3504	20	35	23	2851	12	3	31	2319	22	30
11	15	3	1	30	4688	10	45	3	4467	17	16	19	4025	21	11	45	3423	20	8	2	2773	10	18	48	2275	18	45
15	0	4	1	26	4674	11	39	7	4423	17	50	12	3957	21	23	47	3341	19	21	15	2697	8	25	55	2238	15	0
18	45	5	1	4	4656	12	32	17	4375	18	33	29	3880	21	30	51	3259	18	31	28	2624	6	26	7	2208	11	15
22	30	6	0	1	4634	13	23	56	4324	19	8	24	3813	21	32	27	3177	17	33	2	2554	4	20	46	2186	7	30
26	15	6	58	27	4608	14	13	50	4270	19	40	50	3738	21	28	9	3095	16	25	8	2487	2	11	28	2173	3	45
30	0	7	56	29	4578	15	2	1	4213	20	9	10	3662	21	17	39	3012	15	6	57	2426	0	0	0	2168	0	0
°	'	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	°	'
		— XIs				— Xs				— IXs				— VIIIs				— VIIs				— VIs					
Commutation.																											

TABLE XLIII.

♃ I.

Of Jupiter's mean motion for days.

Days.	Mean motion.					Days.	Mean motion.				
	s	°	′	″	‴		s	°	′	″	‴
1	0	0	4	59	9	1000	2	23	5	46	50
2	0	0	9	58	18	2000	5	16	11	33	40
3	0	0	14	57	26	3000	8	9	17	20	30
4	0	0	19	56	35	4000	11	2	23	7	20
5	0	0	24	55	44	5000	1	25	28	54	10
6	0	0	29	54	53	6000	4	18	34	41	0
7	0	0	34	54	2	7000	7	11	40	27	50
8	0	0	39	53	10	8000	10	4	46	14	40
9	0	0	44	52	19	9000	0	27	52	1	29
10	0	0	49	51	28	10000	3	20	57	48	19
20	0	1	39	42	56	20000	7	11	55	36	39
30	0	2	29	34	24	30000	11	2	53	24	58
40	0	3	19	25	52	40000	2	23	51	13	18
50	0	4	9	17	21	50000	6	14	49	1	37
60	0	4	59	8	49	60000	10	5	46	49	57
70	0	5	49	0	17	70000	1	26	44	38	16
80	0	6	38	51	45	80000	5	17	42	26	35
90	0	7	28	43	13	90000	9	8	40	14	55
100	0	8	18	34	41	100000	0	29	38	3	14
200	0	16	37	9	22	200000	1	29	16	6	29
300	0	24	55	44	3	300000	2	23	54	9	43
400	1	3	14	18	41	400000	3	23	32	12	57
500	1	11	32	53	25	500000	4	28	10	16	11
600	1	19	51	28	6	600000	5	27	48	19	26
700	1	28	10	2	47	700000	6	27	26	22	40
800	2	6	28	37	28	800000	7	27	4	25	54
900	2	14	47	12	9	900000	8	26	42	29	8
1000	2	23	5	46	50	1000000	9	26	20	32	23

Druva $10^{s}\ 15^{\circ}\ 45'\ 16''$.

♃ II.

GURU, OR VRIHASPATI PʼHALA.

Sup. Mean Anomaly.											
°	′	+ 0s — VIs			+ Is — VIIs			+ IIs — VIIIs			°	′
		s	°	′	s	°	′	s	°	′		
0	0	0	0	0	2	35	11	4	26	0	30	0
3	45	0	20	35	2	52	8	4	35	13	26	15
7	30	0	41	0	3	8	19	4	43	18	22	30
11	15	1	1	8	3	23	40	4	50	10	18	45
15	0	1	20	57	3	38	4	4	55	49	15	0
18	45	1	40	19	3	51	32	5	0	13	11	15
22	30	1	59	10	4	4	5	5	3	27	7	30
26	15	2	17	23	4	15	36	5	5	20	3	45
30	0	2	35	11	4	26	0	5	5	58	0	0
°	′	— XIs + Vs			— Xs + IVs			— IXs + IIIs			°	′
Sup. Mean Anomaly.												

The Argument is found by subtracting Jupiter's corrected mean place, from the place of his Apsis.

* * *

TABLE *of* JUPITER'S ANNUAL EQUATION, *and* CHILA CARNA, *The Argument of this Table is found by subtracting Jupiter's mean place corrected, from the Sun's mean place corrected.*

♃ III.

Commutation.														
		+ 0s		+ Is		+ IIs		+ IIIs		+ IVs		+ Vs		
°	′	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	°	′
		° ′ ″	′	° ′ ″	′	° ′ ″	′	° ′ ″	′	° ′ ″	′	° ′ ″	′		
0	0	0 0 0	4107	4 48 49	4040	8 55 14	3827	11 18 20	3506	10 50 57	3152	6 46 59	2871	30	0
3	45	0 36 43	4107	5 23 5	4021	9 20 13	3791	11 25 47	3461	10 32 33	3110	6 2 5	2847	26	15
7	30	1 13 24	4104	5 56 32	3999	9 43 25	3754	11 30 15	3417	10 10 34	3070	5 14 57	2825	22	30
11	15	1 50 1	4099	6 29 6	3976	10 4 42	3716	11 31 44	3372	9 45 3	3032	4 25 44	2807	18	45
15	0	2 26 28	4092	7 0 38	3951	10 23 54	3670	11 30 7	3326	9 16 2	2995	3 34 36	2793	15	0
18	45	3 2 36	4083	7 31 4	3922	10 41 4	3635	11 25 25	3282	8 43 45	2961	2 42 8	2782	11	15
22	30	3 38 19	4071	8 0 33	3892	10 55 58	3593	11 17 15	3238	8 7 43	2928	1 48 37	2774	7	30
26	15	4 13 47	4056	8 28 39	3860	11 8 29	3550	11 5 50	3195	7 28 38	2898	0 54 24	2770	3	45
30	0	4 48 49	4040	8 55 14	3827	11 18 20	3506	10 50 57	3152	6 46 59	2871	0 0 0	2769	0	0
°	′	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	°	′
		— XIs		— Xs		— IXs		— VIIIs		— VIIs		— VIs			
Commutation.															

TABLE XLIV.

♀ I.

Of the mean motion of Venus, for days.

Days.	Mean motion.					Days.	Mean motion.				
	s.	°	′	″	‴		s.	°	′	″	‴
1	0	1	36	7	44	1000	5	12	8	47	1
2	0	3	12	15	27	2000	10	24	17	34	3
3	0	4	48	23	11	3000	4	6	26	21	4
4	0	6	24	30	54	4000	9	18	35	8	5
5	0	8	0	38	38	5000	3	0	43	55	7
6	0	9	36	46	22	6000	8	12	52	42	8
7	0	11	12	54	5	7000	1	25	1	29	9
8	0	12	49	1	49	8000	7	7	10	16	11
9	0	14	25	9	33	9000	0	19	19	3	12
10	0	16	1	17	16	10000	6	1	27	50	14
20	1	2	2	34	32	20000	0	2	55	40	27
30	1	18	3	51	49	30000	6	4	23	30	41
40	2	4	5	9	5	40000	0	5	51	20	54
50	2	20	6	26	21	50000	6	7	19	11	8
60	3	6	7	43	37	60000	0	8	47	1	21
70	3	22	9	0	53	70000	6	10	14	51	35
80	4	8	10	18	10	80000	0	11	42	41	38
90	4	24	11	35	26	90000	6	13	10	32	2
100	5	10	12	52	42	100000	0	14	38	22	16
200	10	20	25	45	24	200000	0	29	16	44	31
300	4	0	38	38	6	300000	1	13	55	6	47
400	9	10	51	30	49	400000	1	28	33	29	2
500	2	21	4	23	31	500000	2	13	11	51	18
600	8	1	17	16	13	600000	2	27	50	13	34
700	1	11	30	8	55	700000	3	12	28	35	49
800	6	21	43	1	37	800000	3	27	6	58	5
900	0	1	55	54	19	900000	4	11	45	20	20
1000	5	12	8	47	1	1000000	4	26	83	42	36

Drura 8ˢ 22° 20′ 19″.

♀ II.

SUCRA P'HALA.

Argument. *											
°	′	+ 0ˢ — VIˢ			+ Iˢ — VIIˢ			+ IIˢ — VIIIˢ		°	′
0	0	0	0	0	0	54	55	1	32	6	30	0
3	45	0	7	28	1	0	45	1	35	5	26	15
7	30	0	14	48	1	6	14	1	37	44	22	30
11	15	0	22	0	1	11	25	1	39	56	18	45
15	0	0	29	2	1	16	15	1	41	47	15	0
18	45	0	35	52	1	20	47	1	43	11	11	15
22	30	0	42	26	1	24	56	1	44	15	7	30
26	15	0	48	48	1	28	41	1	44	50	3	45
30	0	0	54	55	1	32	6	1	45	3	0	0
°	′	— XIˢ + Vˢ			— Xˢ + IVˢ			— IXˢ + IIIˢ			°	′
Argument.												

* The Argument is found by subtracting the Sun's corrected place, from the place of Venus' Apsis.

TABLE *of* Venus' Annual Equation, *and* Chila Carna. *The Argument of this Table is found by subtracting the Sun's mean place corrected, from Venus' mean place corrected.*

♀ III.

Commutation.																											
		+ 0ˢ				+ Iˢ				+ IIˢ				+ IIIˢ				+ IVˢ				+ Vˢ					
°	′	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	°	′
		°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′		
0	0	0	0	0	5940	12	33	19	5734	24	43	32	5152	35	51	32	4241	44	27	30	3075	14	16	37	1786	30	0
3	45	1	34	48	5936	14	6	13	5681	26	10	42	5055	37	6	55	4107	45	9	17	2916	42	34	20	1630	26	15
7	30	3	9	24	5925	15	38	50	5622	27	33	23	4955	38	21	4	3970	45	44	45	2750	40	7	59	1481	22	30
11	15	4	44	0	5909	17	11	18	5558	29	3	34	4846	39	32	9	3828	46	9	56	2594	36	45	59	1341	18	45
15	0	6	18	17	5886	18	42	21	5487	30	27	32	4734	40	39	6	3684	46	23	5	2432	32	14	13	1213	15	0
18	45	7	52	11	5857	20	14	13	5412	31	51	24	4617	41	43	3	3536	46	22	32	2269	26	17	20	1101	11	15
22	30	9	26	1	5822	21	44	40	5331	33	12	47	4496	42	43	41	3385	46	3	43	2106	18	47	30	1013	7	30
26	15	10	59	27	5781	23	14	25	5244	34	33	7	4371	43	38	36	3231	45	23	17	1945	9	51	15	956	3	45
30	0	12	33	19	5734	24	43	32	5152	35	51	32	4241	44	27	30	3075	44	16	37	1786	0	0	0	936	0	0
°	′	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	°	′
		— XIˢ				— Xˢ				— IXˢ				— VIIIˢ				— VIIˢ				— VIˢ					
Commutation.																											

TABLE XLV.

♄ I.

Of Saturn's mean motion for days.

Days.	Mean motion.					Days.	Mean motion.				
	s	°	′	″	‴		s	°	′	″	‴
1	0	0	2	0	23	1000	1	3	26	21	30
2	0	0	4	0	46	2000	2	6	52	43	1
3	0	0	6	1	9	3000	3	10	19	4	31
4	0	0	8	1	32	4000	4	13	45	26	2
5	0	0	10	1	54	5000	5	17	11	47	32
6	0	0	12	2	17	6000	6	20	38	9	3
7	0	0	14	2	40	7000	7	24	4	30	33
8	0	0	16	3	13	8000	8	27	30	52	4
9	0	0	18	3	26	9000	10	0	57	13	34
10	0	0	20	3	49	10000	11	4	23	35	5
20	0	0	40	7	38	20000	10	8	47	10	10
30	0	1	0	11	27	30000	9	13	10	45	15
40	0	1	20	15	16	40000	8	17	34	20	20
50	0	1	40	19	5	50000	7	21	57	55	25
60	0	2	0	22	53	60000	6	26	21	30	30
70	0	2	20	26	42	70000	6	0	45	5	35
80	0	2	40	30	31	80000	5	5	8	40	40
90	0	3	0	24	20	90000	4	9	32	15	41
100	0	3	20	38	9	100000	3	13	55	50	49
200	0	6	41	16	18	200000	6	27	51	41	39
300	0	10	1	54	27	300000	10	11	47	32	28
400	0	13	22	32	36	400000	1	25	43	23	18
500	0	16	43	10	45	500000	5	9	39	14	7
600	0	20	3	48	54	600000	8	23	35	4	56
700	0	23	24	27	3	700000	0	7	30	55	46
800	0	26	45	5	12	800000	3	21	26	46	35
900	1	0	5	43	21	900000	7	5	22	37	25
1000	1	3	26	21	30	1000000	10	19	18	28	14

Druva 2ˢ 23° 53′ 32″.

♄ II.

SANI P'HALA.

Sup. Mean Anomaly.												
°	′	+ 0s — VIs			+ Is — VIIs			+ IIs — VIIIs			°	′
		s	°	′	s	°	′	s	°	′		
0	0	0	0	0	3	51	37	6	38	56	30	0
3	45	0	30	35	4	17	10	6	52	53	26	15
7	30	1	0	57	4	41	36	7	5	9	22	30
11	15	1	30	57	5	4	46	7	15	31	18	45
15	0	2	0	30	5	26	33	7	24	5	15	0
18	45	2	29	26	5	47	0	7	30	45	11	15
22	30	2	57	35	6	5	56	7	35	38	7	30
26	15	3	25	1	6	23	14	7	38	35	3	45
30	0	3	51	37	6	38	56	7	39	31	0	0
°	′	— XIs + Vs			— Xs + IVs			— IXs + IIIs			°	′
Sup. Mean Anomaly.												

The Argument is found by subtracting Saturn's corrected mean place, from the place of his Apsis.

* * *

TABLE *of* SATURN'S ANNUAL EQUATION, *and* CHILA CARNA. *The Argument of this Table is found by subtracting Saturn's mean place corrected, from the Sun's mean place.*

♄ III.

Commutation.																											
		+ 0s				+ Is				+ IIs				+ IIIs				+ IVs				+ Vs					
°	′	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	°	′
		°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′	°	′	″	′		
0	0	0	0	0	3811	2	52	2	3769	5	11	35	3643	6	20	21	3459	5	47	52	3265	3	28	2	3117	30	0
3	45	0	22	2	3810	3	12	1	3758	5	24	49	3623	6	22	20	3434	5	35	56	3242	3	4	25	3104	26	15
7	30	0	44	3	3809	3	31	23	3745	5	36	52	3601	6	22	36	3409	5	22	19	3221	2	39	52	3092	22	30
11	15	1	6	0	3806	3	50	9	3731	5	47	37	3579	6	21	9	3384	5	7	0	3200	2	14	31	3083	18	45
15	0	1	27	47	3801	4	8	11	3716	5	57	3	3556	6	17	59	3359	4	50	4	3181	1	48	26	3077	15	0
18	45	1	49	19	3795	4	25	27	3699	6	5	7	3534	6	13	7	3335	4	31	39	3162	1	21	46	3072	11	15
22	30	2	10	33	3788	4	41	50	3682	6	11	45	3509	6	6	29	3313	4	11	44	3146	0	54	41	3068	7	30
26	15	2	31	29	3779	4	57	13	3663	6	16	51	3484	5	58	2	3289	3	50	29	3131	0	27	23	3066	3	45
30	0	2	52	2	3769	5	11	35	3643	6	26	21	3459	5	47	52	3265	3	28	2	3117	0	0	0	3065	0	0
°	′	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	Equation.			Chila carna	°	′
		— XIs				— Xs				— IXs				— VIIIs				— VIIs				— VIs					
Commutation.																											

TABLE XLVI.

Shewing the Lagna, Chara Cumda, and Ullagna for every Sign of the Ecliptic; calculated for the Latitude of 16° 15′; being that of Banda, near Masulipatam; to which the Commentary refers.

	— I and IV Quadrants.			+ II and III Quadrants.		
	I^s or XII^s.	II^s or XI^s.	III^s or X^s.	IV^s or X^s.	V^s or VIII^s	VI^s or VII^s
Lagna	1670′	1795′	1935′	1935′	1795′	1670′
Chara Cumda	208	169	70	70	169	208
Ullagna	1462	1626	1865	2005	1964	1878

For the Sun's Declination, Right Ascension, and Amplitude, when his Longitude is I, II, and III Signs. See Text, page 97, 98, 101, and 102.

TABLE XLVII. (*)

Being the 4th of the Vakiam process.

For reducing the Moon's place as computed for the time of Sun rising at Lanca, to what it is at a similar instant at another place, stated to be Trivalore near Tanjore, the Longitude of which is 3° 18′ 45″ East of Lanca, and Latitude 10° 41′ N. Communicated by *Sami Nada Sashia* of Poudicherry.

Hindu names of Solar months.		Tamul names of Solar months	Desentara calas. +	Andra vicalas for any day in the same month.
♈	Vaisácha	Chaitram	15′	— 12″
♉	Jyaish'ta	Vyassei	10	— 10
♊	A'shád'ha	Auni	7	— 6
♋	Srávana	Audi	8	+ 2
♌	Bhádrapada	Auvani	11	+ 6
♍	A'swina	Paratasi	17	+ 12
♎	Cártiga	Arpesi	21	+ 8
♏	Márgasíras	Cartiga	28	+ 14
♐	Paushia	Margali	30	— 4
♑	Mágha	Tye	29	— 2
♒	P'hálguna	Maussi	26	— 6
♓	Chaitra	Poongoni	21	— 10

The *Desentara* calas are always additive; and are to be taken for the month which *precedes* that for which the computation is made.

The andra vicalas are for any day in the month the computation is made for. *They are to be used as multiples of the* odd degrees, minutes and seconds of the Sun's true place or Sputa Graha, at Sun rising on the given day; the product of the degrees giving *vicalas* or seconds; that of the minutes, *turparies* or thirds, and so forth.

This latter Equation is to be applied ± to the Moon's uncorrected place, as indicated in the Table.

EXAMPLE.

Let the Sun's Sputa Graha or true place in the Hindu Zodiac on the 24th Audi complete (or 25th at Sun rising) be - - - - - s. ° ′ ″ 3 22 59 3

And the ☽'s uncorrected place at the same instant - - - 4 3 57 13

1° Desentara calas for the month Aani - - - - - + 7 0

2° The andra vicalas (col. 3) for any day in Audi are + 2. The odd degrees of the Sun's Longitude are - - 22° 59′ 3″

therefore - × 2

45‴ 58″ 6‴ or say + 46

☽'s place corrected for Desentara, 24th Audi - - 4 4 4 59

There only remains the Equation of the Arca Bhagábala to be applied to the Moon's corrected place, to have her *Sputa Graha* or true place, at Sun rise on the 25th Audi, at the place computed for.

N. B.—The common Kalendar makers use indiscriminately the above Table for any place in these South Eastern Provinces.

(*) This Table is accidentally inserted out of its place: it should be the XXVIIIth.

TABLE XLVIII.

For the Solar Ahargana *from the beginning of the Cali yug, the mean Solar Sydereal year being* $\frac{1577917828}{4320000}$ *or* 365d 15g 31v 31p 24s.

First Part, *according to the* Surriah Siddhanta.

Years.	Time due to corres-ponding periods.					Years.	Time due to corres-ponding periods.			
	D.	G.	V.	P.	S.		D.	G.	V.	P.
1	365	15	31	31	24	100	36525	52	32	20
2	730	31	3	2	48	200	73051	45	4	40
3	1095	46	34	34	12	300	109577	37	37	0
4	1461	2	6	5	36	400	146103	30	9	20
5	1826	17	37	37	0	500	182629	22	41	40
6	2191	33	9	8	24	600	219155	15	14	0
7	2556	48	40	39	48	700	255681	7	46	20
8	2922	4	12	11	12	800	292207	0	18	40
9	3287	19	43	42	36	900	328732	52	51	0
10	3652	35	15	14	0	1000	365258	45	23	20
20	7305	10	30	28	0	2000	730517	30	46	40
30	10957	45	45	42	0	3000	1095776	16	10	0
40	14610	21	0	56	0	4000	1461035	1	33	20
50	18262	56	16	10	0	5000	1826293	46	56	40
60	21915	31	31	24	0	6000	2191552	32	20	0
70	25568	6	46	38	0	7000	2556811	17	43	20
80	29220	42	1	52	0	8000	2922070	3	6	40
90	32873	17	17	6	0	9000	3287328	48	30	0
100	36525	52	32	20	0	10000	3652587	33	53	20

Names of Solar months according to the Surriah Siddhanta.	Zod. signs	Time due to each month.				
Surriah Siddhanta (separately).						
		D.	G.	V.	P.	S.
Mésha masa	♈	30	55	32	2	39
Vrĭsha m.	♉	31	24	12	2	41
Mid'huna m.	♊	31	36	38	2	44
Carcáta m.	♋	31	28	12	2	42
Sinha m.	♌	31	2	10	2	40
Canyà m.	♍	30	27	22	2	38
Tulà m.	♎	29	54	7	2	35
Vrischica m.	♏	29	30	24	2	33
Dhanus m.	♐	29	20	53	2	31
Macara m.	♑	29	27	16	2	32
Cumbha m.	♒	29	48	24	2	33
Min m.	♓	30	20	21	2	36
Kalendar names (collectively) End of each month.						
Vaisácha	♈	30	55	32	2	39
Jyaishtá	♉	62	19	44	5	20
A'shar	♊	93	56	22	8	4
Srávana	♋	125	24	34	10	46
Bhádrapada	♌	155	26	44	13	26
A'swina	♍	186	54	6	16	4
Cartiga	♎	216	48	13	18	39
Margasiras	♏	246	18	37	21	12
Paushia	♐	275	39	30	23	43
Mágha	♑	305	6	46	26	15
P'hal'guna	♒	334	55	10	28	48
Chaitra	♓	365	15	31	31	24

For the Solar Ahargana from the beginning of the Cali yug, the mean Solar Sydereal year being $\frac{1577917500}{4320000}$ *or* 365d 15g 31v 15p. (*)

Second Part, *according* to the Aria Siddhanta.

Years.	Time of correspond-ing periods.				Years.	Time of correspond-ing periods.		
	D.	G.	V.	P.		D.	G.	V.
1	365	15	31	15	100	36525	52	5
2	730	31	2	30	200	73051	44	10
3	1095	46	33	45	300	109577	36	15
4	1461	2	5	0	400	146103	28	20
5	1826	17	36	15	500	182629	20	25
6	2191	33	7	30	600	219155	12	30
7	2556	48	38	45	700	255681	4	35
8	2922	4	10	0	800	292206	56	40
9	3287	19	41	15	900	328732	48	45
10	3652	35	12	30	1000	365258	40	50
20	7305	10	25	0	2000	730517	21	40
30	10957	45	37	30	3000	1095776	2	30
40	14610	20	50	0	4000	1461034	43	20
50	18262	56	2	30	5000	1826293	24	10
60	21915	31	15	0	6000	2191552	5	0
70	25568	6	27	30	7000	2556810	45	50
80	29920	41	40	0	8000	2922069	26	40
90	32873	16	52	30	9000	3287328	7	30
100	36525	52	5	0	10000	3652586	48	20

Aria Siddhanta (separately).					
		D.	G.	V.	P.
Chaitram	♈	30	55	32	1
Vyassei	♉	31	24	12	1
Aeni	♊	31	36	38	1
Audi	♋	31	28	12	2
Auvani	♌	31	2	10	1
Paratasi	♍	30	27	22	1
Arpesi	♎	29	54	7	1
Cartiga	♏	29	30	21	2
Margali	♐	29	20	53	1
Tye	♑	29	27	16	1
Maussi	♒	29	48	24	1
Poongoni	♓	30	20	21	2
(Collectively) End of each month.					
Chaitram	♈	30	55	32	1
Vyassei	♉	62	19	44	2
Auni	♊	93	56	22	3
Audi	♋	125	24	34	5
Auvani	♌	156	26	44	6
Paratasi	♍	180	54	6	7
Arpesi	♎	216	48	13	8
Cartiga	♏	246	18	37	10
Margali	♐	275	39	30	11
Tye	♑	305	6	46	12
Maussi	♒	334	55	10	13
Poongoni	♓	365	15	31	15

(*) The same Solar year according to the copies of the Aria Siddhanta preserved in Bengal, is [illegible] = 365D 15d 31p 17c 6v this year is unknown in the Peninsula.

[illegible]

TABLE XLIX.

For the Luni-solar Ahargana, from the beginning of the Cali yug, the mean Lunation being $\frac{1577917828}{53433336}$ *or* $29^{d}\ 31^{g}\ 50^{v}\ 0^{p}\ 59^{s},78$.

First Part, *according to the Surriah Siddhanta.* (*)

Years.	Time due to corresponding periods.					Years.	Time due to corresponding periods.					Lunations.	Time due to the *end* of the respective mean Lunar months.				
	D.	G.	V.	P.	S.		D.	G.	V.	P.	S.		D.	G.	V.	P.	S.
1	354	22	1	23	57,14	100	35436	42	19	55	14						
2	708	44	2	47	51,28	200	70873	24	39	50	28	1	29	31	50	6	59,78
3	1063	6	4	11	51,12	300	106310	6	59	45	42	2	59	3	40	13	59,56
4	1417	28	5	35	48,56	400	141746	49	19	40	56	3	88	35	30	20	59,34
5	1771	50	6	59	45,70	500	177183	31	39	36	10	4	118	7	20	27	59,12
6	2126	12	8	23	42,84	600	212620	13	59	31	24	5	147	39	10	34	58,90
7	2480	34	9	47	39,98	700	248056	56	19	26	38	6	177	11	0	41	58,68
8	2834	56	11	11	37,12	800	283493	38	39	21	52	7	206	42	50	48	58,46
9	3189	18	12	35	34,26	900	318930	20	59	17	6	8	236	14	40	55	58,24
10	3543	40	13	59	31,40	1000	354367	3	19	12	20	9	265	46	31	2	58,01
20	7087	20	27	59	2,8	2000	708734	6	33	24	40	10	295	18	21	9	57,80
30	10631	0	41	58	34,2	3000	1063101	9	57	37	0	11	324	50	11	16	57,56
40	14174	40	55	58	5,6	4000	1417468	13	16	49	20	12	354	22	1	23	57,36
50	17718	21	9	57	37,0	5000	1771835	16	36	1	40	13	383	53	51	30	57,14
60	21262	1	23	57	8,4	6000	2126202	19	55	14	0						
70	24805	41	37	56	39,8	7000	2480569	22	14	26	20						
80	28349	21	51	56	11,2	8000	2834936	26	33	38	40						
90	31893	2	5	55	42,6	9000	3189303	29	52	51	0						
100	35436	42	19	55	14,0	10000	3543670	33	12	3	20						

For the Luni-solar Ahargana from the beginning of the Cali yug, the mean Lunation being $\frac{1577917500}{53433336}$ *or* $29^{d}\ 31^{g}\ 50^{v}\ 5^{p}\ 40^{s},21$, *&c.*

Second Part, *according to the Aria Siddhanta.*

Years.	Time due to corresponding periods.					Years.	Time due to corresponding periods.					Lunations.	Time due to the *end* of the respective mean Lunar months.				
	D.	G.	V.	P.	S.		D.	G.	V.	P.	S.		D.	G.	V.	P.	S.
1	354	22	1	8	2,6	100	35436	41	53	24	20						
2	708	44	2	16	5,2	200	70873	23	46	48	40	1	29	31	50	5	40,21
3	1063	6	3	24	7,8	300	106310	5	40	13	0	2	59	3	40	11	20,42
4	1417	28	4	32	10,4	400	141746	47	33	37	20	3	88	35	30	17	0,63
5	1771	50	5	40	13,0	500	177183	29	27	1	40	4	118	7	20	22	40,84
6	2126	12	6	48	15,6	600	212620	11	20	26	0	5	147	39	10	28	21,06
7	2480	34	7	56	18,2	700	248056	53	13	50	20	6	177	11	0	34	1,28
8	2834	56	9	4	20,8	800	283493	35	7	14	40	7	206	42	50	39	41,50
9	3189	18	10	12	23,4	900	318930	17	0	39	0	8	236	14	40	45	21,72
10	3543	40	11	20	26,0	1000	354366	58	54	3	20	9	265	46	30	51	1,94
20	7087	20	22	40	52,0	2000	708733	57	48	6	40	10	295	18	20	56	42,16
30	10631	0	34	1	18,0	3000	1063100	56	42	10	0	11	324	50	11	2	22,38
40	14174	40	45	21	44,0	4000	1417467	55	36	13	20	12	354	22	1	8	2,60
50	17718	20	56	42	10,0	5000	1771834	54	30	16	40	13	383	53	51	13	42,82
60	21262	1	8	2	36,0	6000	2126201	53	24	20	0						
70	24805	41	19	23	2,0	7000	2480568	52	18	23	20						
80	28349	21	30	43	28,0	8000	2834935	51	12	26	40						
90	31893	1	42	3	54,0	9000	3189302	50	6	30	0						
100	35436	41	53	21	20,0	10000	3543669	49	0	33	20						

(*) The Peninsula Astronomers, Tellinga as well as Tamul, invariably use in their computations the Solar *Ahargana* according to the Aria, and the Lunar according to the Surriah, Siddhantas.

USE *and* APPLICATION *of* TABLES XLVIII *and* XLIX.

TABLE XLVIII.

EXAMPLE I.

1° Wanted the Solar Ahargana for the beginning of the Solar year 4924 of the Cali yug, or 4923 complete, (A. D. 1822), according to the Surriah Siddhanta.

	Y.		D.	G.	V.	P.
By Table XLVIII, part 1, we have for	4000	-	1461035	1	33	20
	900	-	328732	52	51	0
	20	-	7305	10	30	28
	3	-	1095	46	34	34
			1798168	51	29	22
Subtract *Sodhyam*, or constant Equation		-	2	8	51	15
Ahargana, 1st Vaisácha ♈, which divide by 7)			1798166	(42	38	7
Remainder			6	which counted from		

Friday, gives Soota dina *Thursday.*

2° Wanted the Ahargana for the 1st of Vrischica masa, or Bengal Márgasíras, of the same year.

	D.	G.	V.	P.
Ahargana for 1st Vaisácha, above found - -	1798166	42	38	7
Add collective number of days registered in the last column down to Cartiga - -	216	48	13	19
Ahargana, 1st Margasiras ♏, which divide by 7)	1798383	(30	51	26
Remainder	6	which counted as usual		

from Friday, gives Soota dina *Thursday.*

EXAMPLE II.

1° Wanted the same, according to the Aria Siddhanta.

	Y.		D.	G.	V.	P.
By Table XLVIII, part 2, we have for	4000	-	1461034	43	20	0
	900	-	328732	48	45	0
	20	-	7305	10	25	0
	3	-	1095	46	33	45
			1798168	29	3	45
Subtract *Sodhyam*		-	2	8	51	15
Ahargana, 1st Chaitram ♈, which divide by 7)			1798166	(20	12	30
Remainder			6	which counted from		

Friday, gives Soota dina *Thursday.*

But here the Civil beginning by the respective accounts will differ, on account of the fraction of days, which by the Surriah Siddhanta is $42^g\ 38^v\ 7^p$, exceeding 30; and by the Aria Siddhanta $20^g\ 12^v\ 30^p$ below 30. Hence the feria of the first Civil day in the year will be, viz. by the Surriah, *Friday;* and by the Aria, *Thursday.*

2° Wanted the Ahargana for the 1st Cartiga (Tamul denomination) of the same year.

	D.	G.	V.	P.
Ahargana for 1st Chaitram, above found - -	1798166	20	12	30
Add collective number of days registered in the last column down to Arpesi - - -	216	48	13	8
Same Ahargana, as by the Surriah Siddhanta -	1798383	8	25	38

subject to the same difference of Civil reckoning.

TABLE XLIX.

EXAMPLE I.

1º Wanted the Luni-solar Ahargana according to the Surriah Siddhanta, for the end of the 4923d year of the Cali yug. The Solar Ahargana for the beginning of the year 4924 being 1798166d 42g 38v 7p.

Use Solar Ahargana as as an Index.

		D.
4924	-	1798166
(1)	-	1744549
		53617
(2)	-	35436
		18131
(3)	-	17718
		463
(4)	-	354
		109
(5)	-	88

Remainder 21 which neglect.

	Y.		D.	G.	V.	P.	S.
By Table XLIX, part 1, column 2, for	4000	-	1417468	13	16	49	20
"	900	-	318930	20	59	17	6
Column 1,	20	-	7037	20	27	59	3
"	3	-	1063	6	4	11	51
Intercalations.		(1)	1744549	0	48	17	20
Column 2,	100	(2)	35436	42	19	55	14
Column 1,	50	(3)	17718	21	9	57	37
"	1	(4)	354	22	1	23	57
3 Lunar months		(5)	88	35	30	20	59
			1798147	[1	49	55	7
			+ 1				
Luni-solar Ahargana sought			1798148				

and for the Soota dina, or day of conjunction

7)1798148d(256878 weeks.

Remainder 2 counted from Thursday, gives *Saturday.*

EXAMPLE II.

2º The same, according to the Aria Siddhanta.

The Solar Ahargana is the same as in the preceding article as to the number of days. The same Index might therefore serve.

4924	-	1798166
(1)	-	1744548
		53618
(2)	-	35436
		18182
(3)	-	17718
		464
(4)	-	354
		110
(5)	-	88
		22

	Y.		D.	G.	V.	P.	S.
By Table XLIX, part 2, column 2, for	4000	-	1417467	55	36	13	20
	900	-	318930	17	0	39	0
	20	-	7087	20	22	40	52
	3	-	1063	6	3	24	7,8
		(1)	1744548	39	2	57	12,8
Intercalations.	100	(2)	35436	41	53	24	20
	50	(3)	17718	20	56	42	10
	1	(4)	354	22	1	8	2,6
3 Lunar months		(5)	88	35	30	17	0,6
			1798146	[39	24	28	53,0
			+ 1				
			1798147				

Proceeding as in Example I, for the Soota dina, it will be found to fall on *Friday.*

N. B.—The Tamul Astronomers, though computing in *Solar time*, use in preference the Luni-solar Ahargana according to the Surriah Siddhanta: and for the Solar, the *Aria Siddhanta.*

TABLE L.

This Table shews the Root or Character of every month in the Mahommedan year, according as that of Mahorum is 1, 2, 3, 4, 5, 6, or 7. It is therefore always to be entered with the Root given in Table I.

	Names of the months.	Number of days in each month.	Roots.						
1	Mahorum	30	1	2	3	4	5	6	7
2	Sepher, or Suffr	29	3	4	5	6	7	1	2
3	Rabi-el-Avul	30	4	5	6	7	1	2	3
4	Rabi-el-Aukeer	29	6	7	1	2	3	4	5
5	Giumadi; or Giumaasil } el-Avul	30	7	1	2	3	4	5	6
6	Giumadi; or Giumaasil } el-Aukeer	29	2	3	4	5	6	7	1
7	Regeb, or Regibab	30	3	4	5	6	7	1	2
8	Shahaban	29	5	6	7	1	2	3	4
9	Ramazan; or Rhamadan	30	6	7	1	2	3	4	5
10	Shawal	29	1	2	3	4	5	6	7
11	Zoolcada; or Zoolcayadah	30	2	3	4	5	6	7	1
12	C Zooledgee; or Zoolcagiadah B	29 or 30	4	5	6	7	1	2	3

N. B.—The month of Zooledgee, consists of 29 or 30 days, according as the year is a common or an intercalary one.

Table LI helps to determine what Hindu Solar year concurs at its beginning with any proposed year of the Hejira; and inversely to indicate, in what year of the Hejira any proposed Solar year happens to begin.

Thus any Hindu Solar year commencing between A. Hejira 1 and 81 has for limits, the 18th (one day *less* than the 19th, registered in the 3d column of the second Section of Table LI), and the 21st (one day *more* than the 20th), March of its concurrent European year, Julian style.

Any Hindu Solar year falling between the 906th and 1009th year of the Hejira cannot commence earlier than the 26th (one day *less* than the 27th), and later than the 28th (one day *more* than the 27th), of March, Old style; or before the 5th and after the 7th April, New style.

TABLE LI.

Exhibiting the respective beginnings of the Hejira, and Hindu Solar, concurrent with European Secular years.

Years of Hejira concurrent with European Secular years.		Hindu Solar years concurrent with European Secular years.				
Anno Hejiræ.	Epoch of beginning.	Anno Cali yugam.	Year of Salivahana or Saca.	Beginning of Hindu Solar years in March.	Beginning of Hindu Solar years in April.	Christian Secular years.
				O. S.	N. S.	
1	16 July	3724	545	19	,,	622
81	26 February	3802	623	20	,,	700
184	1 February	3902	723	20	,,	800
287 288	1 January 26 December	4002	823	21	,,	900
391	1 December	4102	923	22	,,	1000
494	6 November	4202	1023	23	,,	1100
597	12 October	4302	1123	24	,,	1200
700	16 September	4402	1223	25	,,	1300
803	22 August	4502	1323	26	,,	1400
906	28 July	4602	1423	27	6	1500
	O. S. N. S.					
1009	3 July 13 July	4702	1523	27	6	1600
1112	7 ,, 18 June	4802	1623	28	8	1700
1215	13 ,, 25 May	4902	1723	29	10	1800
1318	18 April 1 May	5002	1823	30	12	1900

TABLE LII.

PART THE FIRST.

Shewing the Sun's mean Longitude on the 1st of January of each Secular year of the Julian Kalendar, from A. A. C. 4000 to A. D. 4000, constructed by means of Delalande's Solar Tables I and II (Edition of 1764) for noon time under the Meridian of Paris.

I.					II.					III.		
Years before Christ.					Years after Christ.					☉'s motion for Bissextile years.		
Solar Julian Secular years.	☉'s mean motion.				Solar Julian Secular years.	☉'s mean motion.				Years	☉'s mean motion.	
	s.	°	'	"		s.	°	'	"		'	"
4000	8	7	19	59	0	9	7	57	5	4	1	50,23
3000	8	14	59	15	100	9	8	43	1	8	3	40,45
2000	8	22	38	32	200	9	9	28	56	12	5	30,68
1900	8	23	24	27	300	9	10	14	52	16	7	20,90
1800	8	24	10	23	400	9	11	0	48	20	9	11,13
1700	8	24	56	19	500	9	11	46	43	24	11	1,36
1600	8	25	42	14	600	9	12	32	39	28	12	51,58
1500	8	26	28	10	700	9	13	18	35	32	14	41,80
1400	8	27	14	6	800	9	14	4	30	36	16	32,03
1300	8	28	0	1	900	9	14	50	26	40	18	22,26
1200	8	28	45	57	1000	9	15	36	22	44	20	12,49
1100	8	29	31	53	1100	9	16	22	17	48	22	2,72
1000	9	0	17	48	1200	9	17	8	13	52	23	52,95
900	9	1	3	44	1300	9	17	54	9	56	25	43,17
800	9	1	49	40	1400	9	18	40	4	60	27	33,40
700	9	2	35	35	1500	9	19	26	0	64	29	23,63
600	9	3	21	31	1600	9	20	11	56	68	31	13,86
500	9	4	7	27	1700	9	20	57	51	72	33	4,08
400	9	4	53	22	1800	9	21	43	47	76	34	54,30
300	9	5	39	18	1900	9	22	29	43	80	36	44,53
200	9	6	25	14	2000	9	23	15	38	84	38	34,76
100	9	7	11	9	3000	10	0	54	54	88	40	24,99
0	9	7	57	5	4000	10	8	34	11	92	42	15,21
					300	*	2	17	46,98	96	44	5,43
					400		3	3	42,01	100	* 45	55,66
					500		2	49	38,30	200	1 31	51,32

IV.					
☉'s motion for 4 years either ascending or descending.					
Years ascending.					
1st Common year	—		44'	48",8	
2d do. do.	—		30	29,3	
3d do. do.	—		16	9,8	
4th Bissextile	—		1	50,2	
Years descending.					
1st Com. year.	+	11ˢ	29°	45'	40",5
2d do. do.	+	11	29	31	21,0
3d do. do.	+	11	29	17	1,5
4th Bissextile.	+	0	0	1	50,2

SUPPLEMENTARY TABLE.

Collective number of days at the end of each Solar month.

Bengal names.	Tamul names.	Signs.	Number of days
Vaisácha	Chaitram	♈	30
Jyaishtá	Vyassei	♉	62
A'shád'ha	Auni	♊	93
Srávana	Audi	♋	125
Bhádrapada	Auvani	♌	156
A'swina	Paratasi	♍	186
Cartiga	Arpesi	♎	216
Margasiras or Agrahayan	Cartiga	♏	246
Paushia	Margali	♐	275
Mághu	Tye	♑	305
P'hal'guna	Manssi	♒	334
Chaitra	Poongoni	♓	365

Application of this Table for finding the Sun's mean Longitude on the 1st January of any *Bissextile* Julian year, and on the 31st December of any *Common* year of the same style.

EXAMPLE I.

Wanted the Sun's mean Longitude for A. A. C. 720, a Bissextile.

	s.	°	'	"
By col. I A.A.C.700	9	2	35	35
Col. III for 20 years	—		9	11,13
Mean Long. sought	9	2	26	23,87

and the year being a Bissextile one, the Longitude so found is for the 1st January at noon A. A. C. 720.

EXAMPLE II.

Wanted the same for A. D. 542, a common year.

	s.	°	'	"
By Col. II A.D.500,	9	11	46	43,0
Col. III for 40 years,			18	22,26
Col. IV for 2 years,	11	29	31	21,0
Mean Long. sought	9	11	36	26,26

and the year being a Common one, the Longitude so found is for the 31st December 541.

EXAMPLE III.

Wanted the same for A. D. 1816, a Bissextile year.

	s.	°	'	"
By Col. II A.D.1800,	9	21	43	47,0
Col. III for 16 years,			7	20,9
Mean Long. sought	9	21	51	7,9

and the year being a Bissextile one, the Longitude so found is for 1st January A. D. 1816.

TABLE LII.

PART THE SECOND.

Shewing the Sun's mean motion for days, hours, minutes and seconds, constructed by means of Delalande's Solar Tables III and IV (Edition of 1764). The Supplementary Table being for deducing the European monthly date from any number of days elapsed of the Julian year.

I.					II.						III.			IV.	
Days.	⊙'s mean motion.				Hours.	⊙'s mean motion.		Hours.	⊙'s mean motion.		Minutes.	⊙'s mean motion.		Seconds.	⊙'s mean motion.
	s.	°	′	″		′	″		′	″		′	″		″
1	0	0	59	8,3	1	2	27,8	16	39	25,5	1	0	2,5	1	0,0
2	0	1	58	16,7	2	4	55,7	17	41	53,1	2	0	4,9	2	0,1
3	0	2	57	25,0	3	7	23,5	18	44	21,2	3	0	7,4	3	0,1
4	0	3	56	33,3	4	9	51,4	19	46	49,1	4	0	9,9	4	0,2
5	0	4	55	41,6	5	12	19,2	20	49	16,9	5	0	12,3	5	0,2
6	0	5	54	50,0	6	14	47,1	21	51	44,8	6	0	14,8	6	0,2
7	0	6	53	58,3	7	17	14,9	22	54	12,6	7	0	17,2	7	0,3
8	0	7	53	6,6	8	19	42,8	23	56	40,5	8	0	19,7	8	0,3
9	0	8	52	15,0	9	22	10,6	24	59	8,3	9	0	22,2	9	0,4
10	0	9	51	23,8	10	24	38,5				10	0	24,6	10	0,4
20	0	19	42	46,6	11	27	6,3				20	0	49,3	20	0,8
30	0	29	34	9,9	12	29	34,2				30	1	13,9	30	1,9
40	1	9	25	33,2	13	32	2,0				40	1	38,6	40	1,6
50	1	19	16	56,5	14	34	29,9				50	2	3,2	50	2,1
60	1	29	8	19,8	15	36	57,7				60	2	27,8	60	2,5
70	2	8	59	43,1											
80	2	18	51	6,4											
90	2	28	42	29,7											
100	3	8	23	53,0											
200	6	17	7	46,0											
300	9	25	41	39,0											

SUPPLEMENTARY TABLE.

Shewing the collective number of days elapsed at the end of each European month.

	Days
January	31
February	59
March	90
April	120
May	151
June	181
July	212
August	243
September	273
October	304
November	334
December	365

N. B.—In Bissextile years, *one* day is to be added to the respective sums from February downwards.

For an explanation of the first part of this Table and particularly of its 4th column, see *Delalande's Astronomy*, book VI, vol. I, art. 994 and following: the second part is self-evident, and therefore requires no explanation. But as those who may have occasion to use these Tables may not have that work at their disposition, it may be proper to state that for the sake of conveniency they were arranged on the following principle.

If you have the Sun's mean Longitude for any annual Epoch and you want it for the next, add his *motion* for 365 days, which is 11^{s} 29° 45′ 40″,5, if the following be a *Common* year: but if it be a Leap one, add overmore, the ⊙'s mean motion for *one* day, i. e. 59′ 8″,3, in all 41′ 48″,8: and the Longitude so obtained will be for the 1st January in all *Bissextile*, and for the 31st December in all *Common* years. The aggregate of 1, 2, 3 and 4 years equation is given in column 4th, part 1st, of this Table, and is to be applied as follows, for descending years.

EXAMPLE IV.

Let the Sun's mean Longitude on the 1st January 1816, be found to be

s. ° ′ ″	s. ° ′ ″	s. ° ′ ″	s. ° ′ ″
I. 9 21 43 47	II. 9 21 43 47	III. 9 21 43 47	IV. 9 21 43 47
A. D. 11 29 45 40,5	A. D. 11 29 31 21	A. D. 11 29 17 1,5	A. D. 0 0 1 50,3
1817 - 9 21 29 27,5	1818 - 9 21 15 8	1819 - 9 21 0 48,5	1820 - 9 21 45 37,3
Common	Common	Common	Bissextile
31st December 1816.	31st December 1817.	31st December 1818.	1st January 1820.

On the same principles the Equations for ascending years, such as those before Christ, are to be applied to the Longitude due to the given Epoch with contrary Signs.

EXAMPLE V.

Let the Sun's mean Longitude on the 1st January A. A. C. 720, be (Ex. I.)

s. ° ′ ″	s. ° ′ ″	s. ° ′ ″	s. ° ′ ″
I. 9 2 26 23 87	II. 9 2 26 23,87	III. 9 2 26 23,87	IV. 9 2 26 23,87
B. C. — 41 48,8	B. C. — 30 29,2	B. C. — 16 9,8	B. C. — 1 50,23
721 - 9 1 44 35,07	722 - 9 1 55 54,67	723 - 9 2 10 14,07	724 - 9 2 24 33,64
Common	Common	Common	Bissextile
31st December 720.	31st December 721.	31st December 722.	1st January 724.

I shall now give Examples to shew how to find the Sun's mean Longitude for any particular day or instant, both according to Delalande's Tables, and Table LII.

1º By Delalande's Tables.

N. B.—*In Bissextile years if the proposed date falls* in January or February, retrench one day therefrom.

EXAMPLE VI.

Wanted the Sun's mean Longitude for the 11th March A. A. C. 720, at $6^{h}\ 49'\ 10''$ p. m.

	s.	°	′	″
By Example I, ⊙'s mean Longitude 1st January A. A. C. -	9	2	26	23,87
By Delalande's Table III, ⊙'s motion 11th March -	2	8	59	43,1
Do. Table IV, for 6 hours - - -			14	47,1
49 minutes - - -			2	0,7
10 seconds - - -				0,4
⊙'s mean Longitude sought -	11	11	42	55,17

Here there would be no difference in the process if, instead of Delalande's, we had used Table LII, because in counting the number of days elapsed from the beginning of the year to the 11th March, we would take 31 days in January, 29 in February, and 11 in March: in all 71 days. But because the proposed year is a Bissextile one, and consequently the Sun's mean Longitude at its beginning, is given for the 1st January at noon, *one* day is to be retrenched from the sum; the remainder is therefore 70 days, with which referring to the 1st column of the second part of Table LII, we find $2^{s}\ 8^{\circ}\ 59'\ 43'',1$, the same quantity as is given in Delalande's Table for the 11th March.

EXAMPLE VII.

2º By Table LII.

But if the number of days elapsed are not to be found at once in Table LII, then it must be divided into two parts or more, as the case may require, thus:

Let the Sun's Longitude be required for the 15th March, at $0^{h}\ 0'\ 0''$ A. D. 1817.—We have in January 31^{d}, in February 28, in March 15, sum 74 days.

	s.	°	′	″
By Example IV, ⊙'s mean Longitude 31st December 1816 -	9	21	29	27,5
By Table LII, part 2, col. 1, for 70 days - -	2	8	59	43,1
do. do. 4 days - -	0	3	56	33,3
⊙'s mean Longitude sought -	0	4	25	43,9

The same result would have been obtained by Delalande's Tables, by the addition of only two quantities:

	s.	°	′	″
⊙'s mean Longitude 31st December 1816 - -	9	21	29	27,5
By Table III, 15th March - - -	2	12	56	16,4
Same Longitude as before -	0	4	25	43,9

There remains only to shew how, by means of the same Tables, the time may be deduced from the Sun's mean Longitude, which is only the converse of the preceding operations, but is to be done by trials when the year is known.

EXAMPLE VIII.

Let the proposed Sun's mean Longitude be 7ˢ 5° 38′ 42″ and the year A. D. 542.

By Example II, ⊙'s mean Longitude 31st Dec. 541 -	9ˢ	11°	36′	26″,2	
By Delalande's Table *III* - - -	9	23	43	22,4	25th October.
Table IV - - -			17	14,9	7 hours.
Do. - - -			1	36,1	39 minutes.
				2,4	59 seconds.
25th October, 7ʰ 39′ 59″, corresponding to -	7	5	38	42,0	Longitude.

The same by Table LII.

The operation by Table LII is a little longer than by those of Delalande's, owing to the Sun's motion not being registered in it for every day in the year; but it is to be performed by the same process.

	s.	°	′	″	
⊙'s mean Longitude 31st December 541 -	9	11	36	26,2	
Table LII, part 2, column I - -	6	17	7	46,0	200 days.
	2	28	42	29,7	90
	0	7	53	6,6	8
	0	0	17	14,9	7 hours.
			1	38,6	40 minutes 0s.
- 298 days, 7ʰ 40′ 0″ -	7	5	38	42,0	

Now by the Supplementary Table, part 2, we have

To the end of September -	273 days.
Number of days above found - -	298
October -	25th

The difference of the results by the two sets of Tables is therefore only 1 second of time. It need not be observed, that those who possess Delalande's Tables, will find them the most convenient of the two.

Of the Supplementary Table, Part the First.

Suppose that 298 days have elapsed of the Christian year 542, let it be required to find the Hindu Solar Sydereal date answering to that period which, by the preceding Example, we have found to answer to the 25th October of the said year.

Having determined by the usual process that the Hindu year began on the 19th March, say: from the beginning of the year to the said date there have elapsed 78 days.

But the days expired by proposition are - -	298
Subtract - -	78
	220
By the Supplementary Table, part I, to the end of Arpesi -	216
Remainder -	4

which shews that the 25th October 542, answers to the 4th of the Tamul month *Carliga*; or of the Bengal one *Margasiras.*

⁂

INDIAN

CHRONOLOGICAL TABLES,

WITH DIRECTIONS FOR USING THEM.

AN ACCOUNT

Of three Chronological Tables, the contents of which were calculated on the principles disclosed in the Kala Sankalita*; exhibiting the numerals, names, characters, and epoch of commencement, or end, according to European account, of 200 Solar and Luni-solar years, concurring with those of the Christian XVIIth, XVIIIth, and XIXth Centuries; and including eight different Styles, each being used in some part of India.*

Also the concurrence of the Christian years with those of the Hejira, and the Epoch of commencement of the latter from A. D. 622 *(A. H.* 1*) to A. D.* 1900 *(A. H.* 1318*).*

THE doctrines contained in the *Kala Sankalita,* seem at first sight to be such as to interest only those who intend to make a particular study of Indian Astronomy and Chronology; but little adapted to the occasions and taste of that class of readers for which it was originally intended. On a nearer view however, it will be discovered that although a knowledge of the theories which were investigated in that work, may be dispensed with for using the Tables under consideration, yet in our present state of information on the Elements of Hindu Astronomy, on which Indian Chronology must rest, the latter could have given no satisfaction to any class of readers if they had appeared for the first time supported by no sort of authority.

It is moreover to be considered, that the higher questions on Chronology which may be proposed, such as refer to Astronomy, cannot be resolved by any set of Tables only; and that, in such cases, the most ingeniously contrived and most elaborate Tables, require the assistance of theory.

Yet I am prepared to hear it said that in the elementary part of this work, I have exceeded the necessary bounds of an introduction, and that it would have sufficed, since the production of the Chronological Tables was its ultimate object, to have exhibited the leading features of the systems according to which the Hindus divide time, without entering into those considerations on their manner of operating, which fills so considerable a part of the volume. To which objection I shall answer that had I done so, I would have done nothing; because the difficulty consists principally in our not understanding yet distinctly the mechanism of their computations. For although we have many excellent and profound tracts on the general structure and principles of Hindu Astronomy, yet I do not know of one that would have clearly explained any of the columns of the Tables referred to, although none aspire to any thing higher than the resolution of very simple questions respecting time.

But independently of the above considerations, there is another one, which is of a local nature; and which, if it be true that it applies to our Indian public, must *a fortiori*, act with reduplicated force on all European readers and critics.

There is in every country of Europe a numerous class, which although it cares little for abstract science, yet is well disposed to benefit by its speculations, when aiming at useful results; provided some well qualified person, or body of men, will stand forward, and vouch for the soundness of the principles on which any improvements proposed to its adoption, is grounded: Thus on the signature of some of the members of the Board of Longitude, or of the Academy of the Sciences, the Legislature will adopt, without further examination, a set of new Astronomical Tables, or a new standard measure; and the whole nation will trust to both, without caring if Mendoza valued the accuracy of his Tables more than his life; or how many degrees of the meridian, Delambre and Lambton measured on the surface of the earth.

But in matters of science (and in such matters only), the case stands otherwise in India. If authors are rare amoug us, critics are still scarcer. Business, in all its various acceptations, is the main spring of the actions of the community. The ministers and officers of a great and powerful sovereign, (as Marquis Wellesley emphatically called the Civil Servants of the Company), the Proconsuls who, under the name of Political Residents, govern the courts of Native Princes; and the Merchants, whose whole attention is fixed on the success of their own adventures, have too little leisure to attend to the abstract speculations of the unoccupied; and the military class, like that of every other country, seeks laurels in its appropriate fields.

When, therefore, a production out of the common walks of literature, makes its unexpected appearance, and tries to recommend itself on the score of utility, no one is to be found to imprint that seal upon it, which, like the King's mark on a piece of plate, would cause its practical object to be adopted by the public without a question; and in such a case there being no one to judge for all, every body expects to be enabled to judge for himself.

The same reasons will induce an European reader to be still less confident; for at least in India in a case of peremptory necessity, the Native Sastras may be resorted to; and although they may not be able to convey demonstration according to our own mode of argumentation, many will pronounce with perfect certainty on questions which refer to their theories.

But to what critic in Europe is the reader to address himself, for settling his opinion on a work of this kind?—If the rudiments of Hindu Chronology are so little known to us, who have (not uneducated) spent the most active part of our lives among the Indians, by what criterion, short of a full exposure of its component parts, will he pass judgment on an insulated instrument, which purports to measure time according to the fancies of nations, some of which he perhaps never heard of in the course of his life?

It was therefore not only necessary to draw these oriental elements out of the hidden shelves of the Native Astronomers, but to publish them *in toto*, that the Indian Chronological Tables now presented to the public, might be appreciated according to the degree of merit which they may possess. Thus an Indian author who lights the midnight lamp, and gropes unaccompanied, through the obscure and endless windings of Hindu Astronomy, is not only bound to common accuracy, but (if he rightly calculates his chances of success) he must levy, train and even arm critics, where none were before to be found; and weapons procured by himself, must lie at all times at the disposal of whoever may feel disposed to turn them against his production.

On the use and application of the Tables.

In giving an account of the Chronological Tables, I shall assume that the reader has not perused a line of the *Kala Sankalita;* and that he is totally ignorant of Hindu Astronomy: but that his object is solely to find, with as little trouble as possible, what Indian or Mahommedan year (of a specified account of time) corresponds to a proposed European year. To determine furthermore the Epoch when the year sought commences or ends; and lastly, to fix the date of commencement of any Hindu *Solar* or Mahommedan *month*, when that of the beginning of the year is known, with reference to the European Kalendar, and vice versa.

I shall not detain the reader by a tedious description of each column of the three Tables: the best and readiest account that can be given of these is to refer him to the headings of each, which are sufficiently explicit to dispel all fears of confusion.

Supposing therefore, that their respective contents are known, I shall proceed and give examples of each of the above enumerated cases, propounding first any specific Christian year, according either to the old or new styles; and requiring the name, character and beginning of any year registered in the Table.

EXAMPLES.

I.

First Chronological Table.

Let it be proposed to find the years of all the styles referred to in the first Chronological Table which answer to A. D. 1824, N. S.

The Christian year.

1°. Find the year 1824 in the first column on the left, and keep the eye on the same line.

The numeral of that of the Cali yug.

2°. You will find in column III, that the year of the Cali yug which expires in the month of April is the 4925th; and consequently that the current one after the renewal of the year, is the 4926th.

Do. of Salivahana.

3°. By column IV, that the year *Saca*, or from the birth of *Salivahana*, which expires in April, is the 1746th; and that the year which begins then is the 1747th *Saca*.

Of the Æra of Parasurama.

4°. By column V, that the year of the Æra *Parasurama* which ends in the month of September 1824, is the last or 1-1000th year of the 3d Cycle of the same number of years.

Of the Grahaparivrithi.

5º By column VI, that the Solar year of the Æra *Grahaparivrithi*, which ends in April with the common Solar year, is the 48th of the 20th Cycle complete; and that the next year is the 49th of the 21st Cycle current.

Name of Jupiter's year according to the Surriah Siddhanta.

6º By column VII, that the Vrihaspati, or Jupiter's year which begins (or rather which is supposed to begin) in April 1824, according to the Surriah Siddhanta is *Manmat'ha*, the 29th of the Cycle of 60 years (Bengal).

Do. according to the Tellingas.

7º By column VIII, that the same Vrihaspati year according to the computation of the Tellingas is *Tarana*, the 18th of the Cycle (Peninsula).

For the commencement of all these years.

II.

Beginning of the Solar year, Civil and Sydereal.

1º By column IX, we find that the year of the Cali yug 4925 ends, and the 4926th begins on Sunday the 11th April 1824, *Civil* account.

2º By column X, that A. C. 4926 began on the 10th of April, at 51 guddias, 15 viguddias, Hindu time (20ʰ 30′ European time) after that of Sun rising at Lanca.

3º The year of *Jupiter* being only used for giving a specific name to the Solar and Luni-solar years, their specific duration is not considered in any part of India: and on that account their beginnings are not registered in the Table, though these may be ascertained as precisely as any other.

Of the year of Parasurama.

4º The 1000th year of the 3d Cycle of Parasurama by column V (2d div.) ends on the 14th September 1824: and the following is the 1st year of the 4th Cycle.

NOTE.

The same according to the Julian style.

Previously to A. D. 1752, the Julian Kalendar alone was used in England. On that account a section of column IX gives the date of beginning of the Solar year, according to the old style, from A. D. 1600, to 1750. The two years that are wanting to reach the Epoch of the reformation, not being of sufficient importance to introduce that column in the Table of the second half of the eighteenth century, have been neglected; but may easily be replaced by the reader, if the occasion should require it.

The expunged year of Jupiter's Cycle, by the rules of the Surriah Siddhanta corrected by the Tika, and that by the Jyautistava, do not fall at the same Epoch.

It is also to be observed that during 13 years of a Cycle of 86 years, the *Vrihaspati mana* according to the *Surriah Siddhanta*, and *Jyautistava*, vary; the latter in present times expunging one year out of the Cycle, 13 *years* before the former. When that case occurs, the *Chacra* year according to both accounts, is inserted opposite to the same Christian year; that by the *Surriah Siddhanta* being uppermost. It is therefore necessary, when expounding a date by the sole means of the recorded year of Jupiter, to ascertain which style was prevalent in the country where the document was found or executed. This caution, although already given, in another part of this work, cannot be too often repeated for preventing mistakes.

Example.

To give an Example of the two cases under consideration, I shall select A. D. 1680; answering to the 4781st year complete of the Cali yug. On referring to the first Chronological Table it appears, that whereas the Civil year 4782 began on Monday the 8th April N. S. (column IX), the same Monday answers to the 28th March O. S. (2d part of the same column).

And whereas the *Vrihaspati* year, which answers to the 4782d year of the Cali yug, is *Sucla*, (the third of the Cycle) according to the Surriah Siddhanta corrected, it is *Pramoda* (the 4th) by the *Jyautistava* rule.

It is hardly necessary to add, that the letter B annexed to the numeral of any Christian year, or to the date of beginning of a Hindu Solar year, indicates that it is one of 366 days; called Bissextile when referred to the former. It is proper however, to state, that the Hindu Leap years so indicated, are derived from the *Sydereal* ones. (Vide 1st Memoir, page 12.)

The Bengalee Solar year called *Sen.*

The XIIth column of the first Chronological Table refers to an account of time totally unknown in the Peninsula of India, but used in the Province of Bengal. It registers the years expired of a style written *Sen*, but pronounced *Son*, on the beginning of the common Solar year. The following particulars, which I owe to the favor of Dr. Wilson of the Bengal Service, and which were procured on a reference which I made to him through the kind intervention of my friend Lieutenant Colonel Blacker, (*) constitute all the knowledge I possess on the subject.

(*) Surveyor General of India.

" The Bengal year or *Sen* (pronounced *Son)* 1232 began this year on the
" 11th of April, corresponding to their 1st of Vaisacha—this is the Solar year.
" But the Lunar year begins on the day of the new Moon in Chaitra, and dates
" by the same æra, being adjusted to the Solar year by the intercalation, when
" necessary, of a whole month.

" When the Bengal *Sen* was instituted I have not been able to learn, but it
" is said by some to have been the act of one of the Mahommedan Kings of
" Bengal ; and it seems to bear reference to the *Hejira* year, differing from it
" at present but 8 years.—It seems likely to have originated in some clumsy
" attempt to make the Hindus adopt the Mahommedan computation numerically,
" without adjusting their *Solar* to the *Lunar* year of the Hejira. Consequently
" in about three centuries, it will have lost eight years, or thereabouts, and
" this corroborates the tradition which assigns its introduction to the Mahom-
" medan Kings of Bengal. We have the same date in use on this side of India,
" in Tirhut, and the Western Provinces.

" The Vilaity and Fusselee years, are at present also 1232 : they are both
" Solar years, but differ in their outset. The Vilaity year is reckoned from
" the first of the Krishna Pacsha, or Moon's wane in *Chaitra*,—and the Fus-
" selee on the same in the month of *Ashar*. With the difference of a few
" months, however, they run parallel with the *Sen*, or year of Bengal, and
" probably originated in a similar mistake."

" In saying that they run parallel, however, I mean merely as to the date of
" the year through a long series, for the months and days do not always corres-
" pond."

From the above account we conclude that the numeral of the *Sen* year, serves to designate both the Solar, and Luni-solar years, in the same manner as the names of those of the Cycle of 60, or Vrihaspati years. The way of finding by the Chronological Tables the numeral of the Bengalee year which concurs with any Christian year, is therefore the same in both cases, and requires no particular Example.

N. B.—As the Solar year used in Bengal is that of the Surriah Siddhanta (365^{d} 15^{g} 31^{v} 31^{p} 24^{s}), whereas that of the Peninsula is the year according to

the Aris Siddhanta, ($365^{d}\ 15^{s}\ 31^{v}\ 15^{p}$), there will occasionally be found the difference of one day between the beginning of the *Saura Mana*, as registered in the first Chronological Table, and that which is current in Bengal; for the reasons stated at pages 63, and 118, in the 1st Appendix p. 239, and pages 62 and 65 of the Tables of the *Kala Sankalita*. Thus whilst the present Solar year 4927 of the Cali yug is taken on the Coast to begin on the 11th April; the same year is accounted to commence in Bengal on the 12th April 1825.

It would have been impossible to notice that difference in the General Table, which was principally constructed for the use of the people of the Peninsula.

III.

Second Chronological Table, Luni-solar style.

The second Chronological Table, refers solely to the Luni-solar Astronomical year of the Hindus, called in the Peninsula the *Siddhanta Chandra Mana*. As the construction of that year is very complex, it was not found possible to render the arrangement of the articles registered in its columns, so simple as that of the preceding ones; a proper attention to the following explanations will however, suffice for preventing mistakes.

Column I and II require no explanation.

Column III indicates what is called in this work, the *character* of the Luni-solar year, which *begins* during the Christian year registered in a line with it; namely, whether it be a common one of 12 Lunar months; an intercalary one of 13; or lastly, a double intercalary year with an expunged month, being also of 13 Lunar months; two being repeated, and one being left out. (*)

Indication.

When the approaching Luni-solar year is a common one.

1° When the space opposite to the year expired of the Cali yug, registered in the 2d column, is left *blank*, it is a sign that the Luni-solar year which is about to commence, is a common *Sumvat sara*, and consequently consists of 354 Solar days.

An intercalary one.

2° When the letter A is inserted in the said column, it shews that the Luni-solar year which is commencing is an *Adigah sumvat sara*, or intercalary year, and therefore that it consists of 384 Solar days. (†)

(*) Vide Key to the Siddhanta Chandra Mana, page 71.

(†) For computing what month is to be repeated, see do. page 142.

A double intercalary year with an expunged month.

3º And when the letters AC are found in the same column, it indicates that the new year is a *Cshaya sumvat sara*, or double intercalary year with an expunged month. (*)

How these circumstances were determined may be seen in the 3d part of the Second Memoir, which begins at page 149, the particulars of which are foreign to the object of this article.

Intercalations.

It is to be well understood, that in all the cases registered in the second Chronological Table, the intercalation, or suppression of a Lunar month in the approaching Chandra mana, will occur in all the Christian years registered in a line with the character, in the first column; but only in the Luni-solar year which begins on the expiration of that the numeral of which is given in the second; for in present times the renewal of the Hindu Luni-solar year occurs generally in March, or the beginning of April, so that the same Christian year answers in part to two Hindu ones; and the intercalation always occurs in the latter part of the former. (†)

EXAMPLES.

1º Let the same Christian year 1824, answering to the 4925th and 4926th year of the Cali yug, be proposed.

What indicates a common Luni-solar year.

By Column III, which is left blank, in the same line with 1824, we see that the Luni-solar year 4926 of the Cali yug is a common one, i. e. of 12 Lunar months, or 354 Solar days.

An intercalary.

2º But let A. D. 1801 be proposed, then the letter A opposite to it, in col. III, shews that a Lunar month will be intercalated in the year 4903 of the Cali yug, being the next to 4902 in the 2d column; and therefore, that the former will consist of 13 Lunar months or 384 Solar days.

A double intercalary with an expunged month.

3º Lastly, let the Christian year be A. D. 1822. As we find the character to be A. C. in the 3d column, we conclude that two months will be repeated, and

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(*) For what month is to be expunged, see Key to the Siddhanta Chandra Mana, page 137.

(†) A different arrangement would have confounded all references to the body of the work, in which the Indian system of notation was preserved. The *Ahargunas* given in the IXth and Xth columns would also have no longer tallied with the dates given in the IVth, Vth and VIth, which would have prevented all means of verification.

one expunged in the 4924th year of the Cali yug: so that the Luni-solar year, as in the preceding case, will consist of 13 Lunar months, or 384 Solar days.

How the months to be intercalated, or expunged, are to be determined, is not of the competency of these Tables alone; but the resolution of these Problems will be found at Article 6, Part II, page 142 of the Key to the Siddhanta Chandra Mana, and other places.

Column IV gives the last feria, or weekly day of the Luni-solar year whose numeral is inserted in the second column.

Column V gives the European date of the last *mean conjunction,* according to *Hindu computation* (derived from the Ahargana inserted in column X), which determines the end of the Luni-solar year registered in the 2d column.

Column VI gives the date of the last conjunction in the year, according to Hindu Solar Sydereal account, and because the Luni-solar year always begins during the last month of the *Solar year,* the dates therein registered, refer invariably to the Solar month *Chitra,* the same as the Tamul *Poongoni.*

This column, independently of the Solar Sydereal, also furnishes the means of finding the *Civil* date of the last day in the Luni-solar year; the difference of which is indicated by a stroke before the figure, implying that the numeral of the *Civil* Solar date, is by one day less than the Sydereal one.

Thus if I want the Solar *Sydereal* and *Civil* date of the last day in the year 4923 of the Cali yug, answering to A. D. 1822, I find in column VI opposite to that Christian year, 13th Chitra, which is the Sydereal date; but as there is a stroke — before it, I conclude that the Civil date is the 12th of the same month. (*)

(*) Vide Key to the Siddhanta Chandra Mana, page 82, for the manner of calculating these dates: but as in the article referred to, the Solar Ahargana which was used, is that by the *Surriah Siddhanta*, whereas that by the Chronological Table is the Ahargana according to the *Aria Siddhanta* (which is preferred by all modern Sastras) the results will differ by one day in the Sydereal, though not so in the Civil account, as may be seen by the following computation, which shews the connection of the columns and of the Tables.

1º Solar Ahargana, Chron. Table II, col. IX, A. D. 1822 - 1798166 20 12 30
Luni-solar do. col. X, - - 1798148
Difference - 18

And lastly, by inference, since the Solar *Civil* date of the last conjunction in the year 4923 of the Cali yug fell on the 12th Chitra, it follows that the *Prathama* Tidhi, or first Lunar day of the Luni-solar year 4924, fell on the 13th Chitra of the Solar year 4923, i. e. 19 days before the end of the said year; as was exemplified in the Kalendar exhibited at page 67 of this collection.

This last consideration leads us to another one which may be easily understood, namely, that with reference to the Cycle of Jupiter of 60 years, the Luni-solar will change its name 19 days sooner than the Solar one, the former being called *Vijya* from the 24th March 1822, and the latter still *Nandana* until the 11th April, as may be seen on referring to the first Chronological Table.

In what has been said touching the date of the *Prathama Tidhi* of any year or month, the reader, who is supposed to be unacquainted with the text, must be warned that its being coupled with a particular Solar date, depends on its having begun *before*, or at *Sun* rise; in which case it is coupled with the Solar date with which it mainly coincides.—Or in the latter supposition that it begun *after Sun rise*, for in that case it is registered along with the *ensuing* Solar day. And lastly, that if the said, or any other Tidhi, *begins* and *ends* between two

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to be increased by *one* day, because the Solar counts from *Friday*, and the Luni-solar from *Thursday* = 19 days.

2° By Chron. Table I, col. XI, we find for the same year Root - Thursday (4°) 20 12 30
giving Thursday the 11th April, Civil and Sydereal account.

Subtract the constant Root for the month Chitra, Table III - - (2) 20 21 2

Root 1st Chitra, or Tamul Poongoni - (1) 59 51 28

Monday.

To expound the feria Monday, 1st Chitra, we find by Chronological Table I, column 2, that the Dominical Letter according to the Gregorian Kalendar of the year 1822 is F; with which referring to any Kalendar about the 11th March (about 30 days before the 1st Vaisa'cha shewn by the Table to fall on the 11th April) we find that *Monday* the Sydereal date, actually falls on the 11th March; but on account of the 59 guddias in surplus (exceeding 30g) on the 12th Civil account.

From this computation it is manifest that the Sydereal Solar month Chitra counts 31 days and the Civil only 30, (because the fractional Root for Vaisa'cha was only 20 gud.) Hence if from 1st Vaisa'cha, or 32 days from the 1st Chitra, we retrench 19, there remains 13 for the *Sydereal* date sought, and for the same reason the *Civil* date will be 12th Chitra.

Sun-risings on the same Solar day, it is entirely left out of the Luni-solar Kalendar. (*)

Thus the VIth column of the second Chronological Table expounds three cases by mere inspection, which cannot be resolved by the common rules without very considerable labour. It is almost needless to add, that when the *true* time of Sun rising is referred to, as it occurs in any Latitude or Longitude arbitrarily proposed, the precise Solar date of the *Amavasya*, and *Prathama Tidhis*, above considered, may vary from what it is computed for *Lanca* in the Chronological Table. But as this difference can only occur when the last conjunction falls very near the time of Sun rising, the case is a rare one, and at all events cannot affect the Tabular results, more than one day one way or the other.

The VIIth, VIIIth, IXth and Xth columns of the 2d Chronological Table, can only be of use to those who, having learnt the methods disclosed in the Kala Sankalita, might wish to compute the minuter circumstances of the Luni-solar year, with a view to fix an Epoch with great precision. They are intended to save the computer a vast deal of trouble, and occasions of mistakes, in furnishing him at once with two of the Elements on which all Luni-solar computations depend; and also for giving to the uninformed an opportunity of tracing the connection between the Solar and Luni-solar divisions of time.

Column XI registers the year expired from the origin of the æra of *Vicramaditya*, a style which is used to number the Luni-solar years from an Epoch more recent than the beginning of the Cali yug; in the same manner as the æra of *Salivahana* is applied to the Solar years.

Thus if the numeral of the Luni-solar year which ends in A. D. 1824 be required according to the style of *Vicramaditya*, we find by the column referred to, that it is the 1881st, ending on the 30th March of the said Christian year.

IV.

Third Chronological Table, æra of the Hejira Lunar years.

The third Chronological Table, which is general for all years of the Hejira from A. D. 622 to 1900, is so constructed, that when you have found the

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(*) Vide Key to the Siddhanta Chandra Mana, page 72.

numeral of the Mahommedan year which corresponds to the proposed Christian one, you know (what is called) the *Character* of the year; by which is meant the feria or weekly day on which it begins; and this *Root*, or Character, serves to find the commencement of every month in the Lunar year: for the years of the Hejira are arranged in the respective columns according to the day of the week on which each begins. This arrangement though in some respects less convenient than when the common series is followed, has in others, the advantage of avoiding errors when taking the numerals and other indices of the circumstances of the Lunar year out of the Table; and affords great facilities for comparing the Initial Roots and *Soota dina* of the Indian and Mahommedan years.

The æra of the Hejira is divided into cycles of 30 years, at the end of which, the intercalation of the months, which occur in the 2d, 5th, 7th, 10th, 13th, 16th, 18th, 21st, 24th, 26th and 29th resume the same series. In intercalary years, one day is to be added to the last Lunar month, called Zooledgee; making that month consist of 30 days instead of 29, which is its duration in common years. These are indicated by the letter B, and the years ending the cycle of 30 years by a stroke == and asterisk * above and below the same year.

Example.

Example.

Let it be required to find the numeral, and date of the commencement of the year of the Hejira which answers to A. D. 1824.

Referring to that part of the General Table which contains the years of the XIXth century, I find A. H. 1240 in the column under *Thursday*; its Root is therefore 5: it appears also that its beginning falls on the 14th O. S. and 26th August N. S. and as it is marked with an asterisk (x), that it is an *intercalary* one, i. e. of 355 Solar days; its month Zooledge counting 30 days. This process is so simple, that it requires no further exemplification.

To find by means of the first Chronological Table the European date of beginning of each Solar month of the Hindu Sydereal years.

V.

How to expound the beginning of the Hindu Solar months.

For this purpose I shall give here an abridgment of Table III of the present collection, which will suffice for resolving all common cases.

(x) Em. read B

The Root of days to be counted from Sunday.

	Hindu names of Solar months.	Tamul names of months.	Root of duration of every Solar month.	Collective Roots of months according to their standing in the year.	European months concurring N. S.
			D. G. V. P.	D. G. V. P.	
♈	Vaisácha	Chaitram	(2) 55 32 1	(2) 55 32 1	April
♉	Jyaishtá	Vyassei	(3) 21 12 1	(6) 19 44 2	May
♊	Ashar	Auni	(3) 36 38 1	(2) 56 22 3	June
♋	Srávana	Audi	(3) 28 12 2	(6) 24 34 5	July
♌	Bhádra	Auvani	(3) 2 10 1	(2) 26 44 6	August
♍	A'swina	Paratasi	(2) 27 22 1	(4) 54 6 7	September
♎	Cartiga	Arpesi	(1) 54 7 1	(6) 48 13 8	October
♏	Margasiras	Cartiga	(1) 30 24 2	(1) 18 37 10	November
♐	Paushia	Margali	(1) 20 53 1	(2) 39 30 11	December
♑	Mágha	Tye	(1) 27 16 1	(4) 6 46 12	January
♒	P'hal'guna	Maussi	(1) 48 24 1	(5) 55 10 13	February
♓	Chaitra	Poongoni	(2) 20 21 2	(1) 15 31 15	March

EXAMPLE 1.

Examples. Let it be proposed to find the European date of commencement of the Solar month *Jyaishtá* (Tamul *Vyassei*) of the 4926th year of the Cali yug, answering to A. D. 1824.

1° Referring to the first Chronological Table we find opposite to 1824 the Initial Root of the Solar year, - - 10th April (6^{d}) 51^{g} 15^{v} 0^{p}
To which add that for the month Vaisácha in the above Table (2) 55 32 1

Initial Root 1st of Jyaishtá - (2) 46 47 1

Tuesday, SYDEREAL: Wednesday, CIVIL (*).

2° To expound the monthly dates of these feriæ, we find in the second column opposite to 1824 (1st Chronological Table) that the Dominical Letters for that year, according to the new style, are DC. Referring therefore to any Kalendar with the Letter C, about 30 days after the 10th April, we find that the Tuesday above found, falls on the 11th, and Wednesday on the 12th May, which are the Sydereal and Civil dates of beginning of the Solar month Vaisácha sought.

(*) The Civil account takes one day more when the fraction of the Root in guddias exceed 30.

EXAMPLE II.

Let the commencement of the Solar month Mágha (Tamul Tye) be required.

	D.	G.	V.	P.
The Initial Root for A. C. 4926 remaining as before -	(6)	51	15	0
Take out of the small Table the Collective Root up to *Paushia*, which add - - -	(2)	39	30	11
Initial Root 1st of *Mágha* -	(2)	30	45	11

Tuesday, SYDEREAL: *Wednesday*, CIVIL.

Here as the Solar month *Mágha*, falls in *January* of the year 1825, we refer again to the first Chronological Table for the Dominical Letter of that year, which we find to be B, and as the beginning of the eleven last months of the year cannot fall wider in each month from the date of the 1st Vaisácha in April than 4 days, (*) referring to the Kalendar in January 1825, we find the Tuesday above found to fall on the 11th January; and Wednesday on the 12th, being the *Sydereal* and *Civil* date of the 1st Mágha (Tamul Tye) sought.

The above method is so plain, that it would be useless to multiply examples any further.

VI.

The beginning of the Lunar months of the Chandra Mana not susceptible of being determined by the Tables.

As for determining the beginning of the Lunar months of the Siddhanta Chandra Mana by means of Tables only, it was abundantly shewn in the text that such an attempt would be vain; because the Tidhis of which these months are composed, depend on no absolute progress of the Sun or Moon in their orbits; but on their apparent relative motion; and because the manner of registering them in the Kalendar is determined by circumstances which have never been attended to by any other known people. (†)

Supposing however, that the reduction of any number of *Tidhis* into a corresponding one of Solar days, could be effected with precision by a mechanical process, this would be of little advantage in practice; for the Luni-solar style has long since been banished from all civil concerns, and was only retained for the superstitious observances and practices of the Hindus.

(*) Vide Key to the Madhyama Saura Mana, page 15.

(†) Vide Key to the Siddhanta Chandra Mana, page 72.

Approximation of the same.

If nevertheless, an approximation of the European date of the *Prathama* Tidhi of any of the Lunar months of the year were absolutely wanted, it may be obtained by the following easy process.

As whatever be the real duration of the Lunar Synodical month, it is always divided into 30 Tidhis, the last of which is that of the *Amavasya* or conjunction, and as the common Lunar Civil year is of 354 *Bhumi Savan*, or natural days (more nearly $354^d\ 22^g\ 1^v\ 12^p$), we have the following proportion.

As 360 Tidhis, to 354 Solar days, so 30 Tidhis, to $29\frac{1}{2}$ Solar days.—Hence if to the date of last mean conjunction in the preceding year, given in the fifth column of the second Chronological Table, we add as many times 29 days 30 guddias, as the proposed month is removed of units from the first month in the year, we shall have nearly the Civil date of its end.

EXAMPLE.

Example.

Thus let the same year of the Cali yug 4926 (A. D. 1824) be again proposed, finding by column V, 2d Chronological Table, that the last Amavasya of 4925 fell on Tuesday the 30th March, if to this date we add $29^d\ 30^g$, the last Amavasya of the Lunar month Chitra will fall nearly on the 29th of April; and the *Prathama* Tidhi of Vaisácha on the 30th. For the last Amavasya in Vaisácha, it will be $2 \times 29^d\ 30^g = 59$ days, which added as before to the 30th March will fall on the 28th May, and the Prathama Tidhi of the Lunar month *Jyaishtá* will be the 29th nearly. And lastly, for the end of the Lunar month *Mágha*, the 11th of the Chandra Mana, we have $11 \times 29^d\ 30^g$, or $324^d\ 30^g$, which added to the 30th March 1824, will give the 17th February 1825, the *Prathama* Tidhi of *P'hal'guna*, the 12th Lunar month falling very nearly on the 18th February.

If the year which is proposed, be marked with an A, or AC in the third column of the Chronological Table, which indicates a year of 13 Lunar months, or 384 days, (more nearly $383^d\ 55^g\ 57^v\ 48^p$) then the arrangement of the months in the new *Chandra Mana*, will be disturbed by the intercalation; and as the Table does not inform us which is the intercalated month, the above process will only indicate the *numerals*, and not the *names* of the successive months: but it will still approximate the date of their endings: for $13 \times 29^d\ 30^g = 383^d\ 30^g$, very near the true duration of the intercalated Luni-solar year.

For the European date of the commencement of the Mahommedan Lunar months.

How to expound the beginning of the Mahommedan months.

There remains now only to shew how the beginnings of the months of the Lunar year of the Mahommedans may be computed by help of the third General Table, for which we have the following subsidiary one.

Number of days in each month	Names of Arabic months.	Initial feriæ of months.						
30	Mahorum - -	1	2	3	4	5	6	7
29	Sepher - - -	3	4	5	6	7	1	2
30	Rabi-el-Avul -	4	5	6	7	1	2	3
29	Rabi-el-Aukeer -	6	7	1	2	3	4	5
30	Giumadi-el-Avul -	7	1	2	3	4	5	6
29	Giumadi-el-Aukeer	2	3	4	5	6	7	1
30	Regeb - - -	3	4	5	6	7	1	2
29	Shahaban - -	5	6	7	1	2	3	4
30	Rhamadan - -	6	7	1	2	3	4	5
29	Shawal - - -	1	2	3	4	5	6	7
30	Zoolcada - -	2	3	4	5	6	7	1
29 or 30	Zooledgee - -	4	5	6	7	1	2	3

The Civil months, as has already been said, are alternately of 30 and 29 days, excepting the last, which in common years is of 29, and in intercalary ones, of 30 days.

The figures in a line with *Mahorum*, indicate the 7 feriæ by which the Mahommedan year may begin, 1 answering to Sunday, 2 to Monday, and so forth to 7 which answers to Saturday.

The figures which follow underneath in the same perpendicular line, shew the initial feriæ of all the other months in the same year. With regard to the Dominical Letter which is necessary for expounding the European date, it may be either deduced from Table III, or found at once in Table II. As for the application of these data, it will best be shewn by an

Example.

Example.

Let the same year 1824 be proposed, which as we have found at page xv, answers to the 1240th of the Hejira, the Root of which is 5; and whose beginning falls on the 26th August N. S.

Referring to the subsidiary Table, we refer to the column at the top of which 5 is registered, then following it downwards, we find 7, or Saturday, the initial feria of *Sepher*; then counting 30 days from the 26th August, we find that the said month begins on the 25th September.

For Rabi-el-Avul, the next Root is 1, or Sunday; then counting 29^{d} from the 25th September, we find that the said month begins on the 24th of October; and so forth, down to the 12th month Zooledgee.

For this last month, as we find a B annexed to the 1240th year of the Hejira in the third Chronological Table, we conclude that it is an intercalary one; therefore, after having determined by the preceding process that Zooledgee began on *Sunday* the 17th July (the Dominical Letter being now B), instead of counting 29 days from that date, we are to take 30, which adding to the 17th July, falls on Tuesday the 16th of August, the initial feria and date of beginning of the 1241st year of the Hejira; as may be seen on referring to the General Table.

The converse of all the preceding methods, is too obvious to need any particular Example; because all that is required is, to refer to the Chronological Tables with the Indian or Mahommedan year proposed. The European year concurring therewith being registered on the same line in its appropriate column, the question is at once reduced to some of those which were proposed in the preceding cases, and therefore needs no further explanation.

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FIRST CHRONOLOGICAL TABLE, *referring to various Indian Solar styles and years; and showing the numerals or names, and the Epoch of the commencement of the latter according to European accounts.*

I.	II.		III.	IV.	V.		VI.	VII.		VIII.		IX.			X.		XI.					XII.
Christian years.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Cali yug.	Years expired from the birth of Salivahana.	Expired years of the Æra Parasurama. Years of the Cycle.	Initial date.	Years of the Cycle of 90 Grahaparivritti.	Years of the Cycle of 60 years or *Vrihaspati*, Bengal reckoning. Current years.	Numerals.	Years of the Cycle of 60 years as reckoned South of the River Nermada. Current years	Numerals.	Initial feriæ; Tamul civil account N. S.	Date in April N. S.	Date in March O. S.	Initial feriæ of Tamul Sydereal years N. S.	Date in April N. S.	Roots of beginnings of Tamul years counted from Sunday.	D.	G.	V.	P.	Bengalee years called Sen.
1600	FE	BA	4701	1522	776	Sep. 10	4	Saumya	43	Sarvarí	34	Fri	7	Syd. 27	Th	6	B	(4)	54	35	0	1006
1	D	G	2	3	7	11	5	Sádhárana	44	Plava	35			28	Sat	7		(6)	10	6	15	7
2	C	F	3	4	8	11	6	Viródhacrit	45	Subhacrit	36			28	Sun	7		(0)	25	37	30	8
3	B	E	4	5	9	11	7	Paridhávi	46	Sóbhana	37	Tu	8	28	Mo	7		(1)	41	8	45	9
B 4	AG	DC	5	6	780	10	8	Pramádi	47	Crádhi	38	We	7	27	Tu	6	B	(2)	56	40	0	1010
5	F	B	6	7	1	10	9	A'nanda	48	Viswávasù	39			28	Th	7		(4)	12	11	15	1
6	E	A	7	8	2	11	10	Rac'shasa	49	Parábhava	40			28	Fri	7		(5)	27	42	30	2
7	D	G	8	9	3	11	11	Anala	50	Plavanga	41	Sun	8	28	Sat	7		(6)	43	13	45	3
B 8	CB	FE	9	1530	4	10	12	Pingala	51	Cilaca	42	Mo	7	27	Sun	6	B	(0)	58	45	0	4
9	A	D	4710	1	5	10	13	Cálayucta	52	Saumya	43			28	Tu	7		(2)	14	16	15	5
1610	G	C	1	2	6	11	14	Sidh'arti	53	Sádhárana	44			28	We	7		(3)	29	47	30	6
1	F	B	2	3	7	11	15	Raudra	54	Viródhacrit	45	Fri	8	28	Th	7	B	(4)	45	18	45	7
B 2	ED	AG	3	4	8	10	16	Durmati	55	Paridhávi	46			28	Sat	7		(6)	0	50	0	8
3	C	F	4	5	9	11	17	Dundubhi	56	Pramádi	47			28	Sun	7		(0)	16	21	15	9
4	B	E	5	6	790	11	18	Rudiródgari	57	A'nanda	48	Tu	8	28	Mo	7		(1)	31	52	30	1020
5	A	D	6	7	1	11	19	Ractacsha	58	Rac'shasa	49	We	8	28	Tu	7	B	(2)	47	23	45	1
B 6	GF	CB	7	8	2	10	20	Cródhana	59	Anala	50			28	Th	7		(4)	2	55	0	2
7	E	A	8	9	3	11	21	Cshya	60	Pingala	51			28	Fri	7		(5)	18	26	15	3
8	D	G	9	1540	4	11	22	Prabhava	1	Cálayucta	52	Sun	8	28	Sat	7		(6)	33	57	30	4
9	C	F	4720	1	5	11	23	Vibhava	2	Sidh'arti	53	Mo	8	27	Sun	7	B	(0)	49	28	45	5
1620	BA	ED	1	2	6	11	24	Sucla	3	Raudra	54			28	Tu	7		(2)	5	0	0	6
1	G	C	2	3	7	11	25	Pramoda	4	Durmati	55			28	We	7		(3)	20	31	15	7
2	F	B	3	4	8	11	26	Prajápati	5	Dundubhi	56	Fri	8	28	Th	7		(4)	36	2	30	8
3	E	A	4	5	9	11	27	Angira	6	Rudiródgari	57	Sat	8	28	Fri	7	B	(5)	51	33	45	9
B 4	DC	GF	5	6	800	11	28	Srimuc'ha	7	Ractácsha	58			28	Sun	7		(0)	7	5	0	1030
5	B	E	6	7	1	11	29	Bhává	8	Cródhana	59			28	Mo	7		(1)	22	36	15	1
6	A	D	7	8	2	11	30	Yuvá	9	Cshya	60	We	8	28	Tu	7		(2)	38	7	30	2
7	G	C	8	9	3	11	31	Dhátá	10	Prabhava	1	Th	8	28	We	7	B	(3)	53	38	45	3
B 8	FE	BA	9	1550	4	11	32	Iswara	11	Vibhava	2			28	Fri	7		(5)	9	10	0	4
9	D	G	4730	1	5	11	33	Bahudanya	12	Sucla	3			28	Sat	7		(6)	24	41	15	5
1630	C	F	1	2	6	11	34	Pramát'hi	13	Pramoda	4	Mo	8	28	Sun	7		(0)	40	12	30	6
1	B	E	2	3	7	11	35	Vicrama	14	Prajápati	5	Tu	8	28	Mo	7	B	(1)	55	43	45	7
B 2	AG	DC	3	4	8	11	36	Brisya	15	Angira	6			28	We	7		(3)	11	15	0	8
3	F	B	4	5	9	11	37	Chitrab'hanu	16	Srimuc'ha	7			28	Th	7		(4)	26	46	15	9
4	E	A	5	6	810	11	38	Súbhánu	17	Bhává	8	Sat	8	28	Fri	7		(5)	42	17	30	1040
5	D	G	6	7	1	11	39	Tárana	18	Yuvà	9	Sun	8	28	Sat	7	B	(6)	57	48	45	1
B 6	CB	FE	7	8	2	11	40	Párthiva	19	Dhátá	10			28	Mo	7		(1)	13	20	0	2
7	A	D	8	9	3	11	41	Vyaya	20	Iswara	11			28	Tu	7		(2)	28	51	15	3
8	G	C	9	1560	4	11	42	Sarvajit	21	Bahudanya	12	Th	8	28	We	7		(3)	44	22	30	4
9	F	B	4740	1	5	11	43	Sarvadhári	22	Pramát'hi	13	Fri	8	28	Th	7	B	(4)	59	53	45	5
1640	ED	AG	1	2	6	11	44	Viródhi	23	Vicrama	14			28	Sat	7		(6)	15	25	0	6
1	C	F	2	3	7	11	45	Vicrita	24	Brisya	15	Mo	8	28	Sun	7		(0)	30	56	15	7
2	B	E	3	4	8	11	46	C'hara	25	Chitrab'hanu	16	Tu	8	28	Mo	7	B	(1)	46	27	30	8
3	A	D	4	5	9	11	47	Nandana	26	Súbhánu	17			29	We	8		(3)	1	58	45	9
B 4	GF	CB	5	6	820	11	48	Vijya	27	Tárana	18			28	Th	7		(4)	17	30	0	1050
5	E	A	6	7	1	11	49	Jya	28	Párthiva	19	Sat	8	28	Fri	7		(5)	33	1	15	1
6	D	G	7	8	2	11	50	Manmat'ha	29	Vyaya	20	Sun	8	28	Sat	7	B	(6)	48	32	30	2
7	C	F	8	9	3	12	51	Durmuch'ha	30	Sarvajit	21			29	Mo	8		(1)	4	3	45	3
B 8	BA	ED	9	1570	4	11	52	Hemalamva	31	Sarvadhári	22			28	Tu	7		(2)	19	35	0	4
9	G	C	4750	1	5	11	53	Vilamva	32	Viródhi	23	Th	8	28	We	7		(3)	35	6	15	5
1650	F	B	1	2	6	11	54	Vicari	33	Vicrita	24	Fri	8	28	Th	7	B	(4)	50	37	30	6

I.	II.		III.	IV.	V.		VI.	VII.		VIII.		IX.			X.		XI.				XII.
Christian years.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Cali yug.	Years expired from the birth of Salivahana.	Expired years of the Æra Parasurama. Years of the Cycle.	Initial date	Years of the Cycle of 90 Grahaparivritti.	Years of the Cycle of 60 years or *Vrihaspati*, Bengal reckoning. Current years.	Numerals.	Years of the Cycle of 60 years as reckoned South of the River Nermada. Current years	Numerals.	Initial feriæ; Tamul civil account N. S.	Date in April N. S.	Date in March O. S.	Initial feriæ of Tamul Sidereal years N. S.	Date in April N. S.	Roots of beginnings of Tamul years counted from Sunday. D.	G.	V.	P.	Bengalee years called Sen.
						Sep.								Syd.							
1651	E	A	4752	1573	827	12	55	Sarvari	34	C'hara	25			29	Sat	8	(6)	6	8	45	1057
B 2	DC	GF	3	4	8	11	56	Plava	35	Naudana	26			28	Sun	7	(0)	21	40	0	8
3	B	E	4	5	9	11	57	Subhacrit	36	Vijya	27	Tu	8	28	Mo	7	(1)	37	11	15	9
4	A	D	5	6	830	11	58	Sóbhana	37	Jya	28	We	8	28	Tu	7	B (2)	52	42	30	1060
5	G	C	6	7	1	12	59	Crádhi	33	Manmat'ha	29			29	Th	8	(1)	8	13	45	1
B 6	FE	BA	7	8	2	11	60	Viswávasù	39	Durmuch ha	30			28	Fri	7	(5)	23	45	0	2
7	D	G	8	9	3	11	61	Parábhava	40	Hemalumva	31	Sun	8	28	Sat	7	(6)	39	16	15	3
8	C	F	9	1580	4	11	62	Plavanga	41	Vilamva	32	Mo	8	28	Sun	7	B (0)	54	47	30	4
9	B	E	4760	1	5	12	63	Cílaca	42	Vicari	33			29	Tu	8	(2)	10	18	45	5
1660	AG	DC	1	2	6	11	64	Saumya	43	Sarvari	34			28	We	7	(3)	25	50	0	6
1	F	B	2	3	7	11	65	Sádhárana	44	Plava	35	Fri	8	28	Th	7	(4)	41	21	15	7
2	E	A	3	4	8	11	66	Viródhacrit	45	Subhacrit	36	Sat	8	28	Fri	7	B (5)	56	52	30	8
3	D	G	4	5	9	12	67	Paridhávi	46	Sóbhana	37			29	Sun	8	(0)	12	23	45	9
B 4	CB	FE	5	6	840	11	68	Pramádi	47	Crádhi	38			28	Mo	7	(1)	27	55	0	1070
5	A	D	6	7	1	11	69	A'nanda	48	Viswávasù	39	We	8	28	Tu	7	(2)	43	26	15	1
6	G	C	7	8	2	11	70	Rac'shasa	49	Parábhava	40	Th	8	28	We	7	B (3)	58	57	30	2
7	F	B	8	9	3	12	71	Anala	50	Plavanga	41			29	Fri	8	(5)	14	28	45	3
B 8	ED	AG	9	1590	4	11	72	Pingala	51	Cílaca	42	Sun	8	28	Sat	7	(6)	30	0	0	4
9	C	F	4770	1	5	11	73	Cálayucta	52	Saumya	43	Mo	8	28	Sun	7	B (0)	45	31	15	5
1670	B	E	1	2	6	11	74	Sidh'arti	53	Sádhárana	44			29	Tu	8	(2)	1	2	30	6
1	A	D	2	3	7	12	75	Raudra	54	Viródhacrit	45			29	We	8	(3)	16	33	45	7
B 2	GF	CB	3	4	8	11	76	*Durmati* (*) Durm. Dund.	55 55,56	Paridhávi	46	Fri	8	28	Th	7	(4)	32	5	0	8
3	E	A	4	5	9	11	77	*Dundubhi* Rudiródgari	56 57	Pramádi	47	Sat	8	28	Fri	7	B (5)	47	36	15	9
4	D	G	5	6	850	11	78	*Rudirôdgari* Ractácsha	57 58	A'nanda	48			29	Sun	8	(0)	3	7	30	1080
5	C	F	6	7	1	12	79	*Racta'csha* Cródhana	58 59	Rac'shasa	49			29	Mo	8	(1)	18	38	45	1
B 6	BA	ED	7	8	2	11	80	*Cródhana* Cshya	59 60	Anala	50	We	8	28	Tue	7	(2)	34	10	0	2
7	G	C	8	9	3	11	81	*Cshya* Prabhava	60 1	Pingala	51	Th	8	28	We	7	B (3)	49	41	15	3
8	F	B	9	1600	4	12	82	*Prabhava* Vibhava	1 2	Cálayucta	52			29	Fri	8	(5)	5	12	30	4
9	E	A	4780	1	5	12	83	*Vibhava* Sucla	2 3	Sidh'arti	53			29	Sat	8	(6)	20	43	45	5
1680	DC	GF	1	2	6	11	84	*Sucla* Pramoda	3 4	Raudra	54	Mo	8	28	Sun	7	(0)	36	15	0	6
1	B	E	2	3	7		85	*Pramoda* Prajápati	4 5	Durmati	55	Tu	8	28	Mo	7	B (1)	51	46	15	7
2	A	D	3	4	8	12	86	*Praja'pati* Angira	5 6	Dundubhi	56			29	We	8	(3)	7	17	30	8
3	G	C	4	5	9	12	87	*Angira* Srimu'cha	6 7	Rudiródgari	57			29	Th	8	(4)	22	48	45	9
B 4	FE	BA	5	6	860	11	88	*Srimu. Bhává* Bhává	7 8 8	Ractácsha	58	Sat	8	28	Fri	7	(5)	38	20	0	1090
5	D	G	6	7	1	11	89	Yuva	9	Cródhana	59	Sun	8	28	Sat	7	B (6)	53	51	15	1
6	C	F	7	8	2	12	90	Dhátá	10	Cshya	60			29	Mo	8	(1)	9	22	30	2
7	B	E	8	9	3	12	Cycle 1	Iswara	11	Prabhava	1			29	Tu	8	(2)	24	53	45	3
B 8	AG	DC	9	1610	4	11	2	Bahudanya	12	Vibhava,	2	Th	8	28	We	7	(3)	40	25	0	4
9	F	B	4790	1	5	11	3	Pramat'hi	13	Sucla	3	Fri	8	28	Th	7	B (4)	55	56	15	5
1690	E	A	1	2	6	12	4	Vicrama	14	Pramoda	4			29	Sat	8	(6)	11	27	30	6
1	D	G	2	3	7	12	5	Brisya	15	Prajápati	5			29	Sun	8	(0)	26	58	45	7
B 2	CB	FE	3	4	8	11	6	Chitrab'hanu	16	Angira	6	Tu	8	28	Mo	7	(1)	42	30	0	8
3	A	D	4	5	9	11	7	Súbhána	17	Srimuc'ha	7	We	8	28	Tu	7	B (2)	58	1	15	9
4	G	C	5	6	870	12	8	Tárana	18	Bhává	8			29	Th	8	(4)	13	32	30	1100
5	F	B	6	7	1	12	9	Párthiva	19	Yuva	9			29	Fri	8	(5)	29	3	45	1
B 6	ED	AG	7	8	2	11	10	Vyaya	20	Dháta	10	Sun	8	28	Sat	7	B (6)	44	35	0	2
7	C	F	8	9	3	11	11	Sarvajit	21	Iswara	11			29	Mo	8	(1)	0	6	15	3
8	B	E	9	1620	4	12	12	Sarvadhári	22	Bahudanya	12			29	Tu	8	(2)	15	37	30	4
9	A	D	4800	1	5	12	13	Viródhi	23	Pramát'hi	13	Th	9	29	We	8	(3)	31	8	45	5
1700	GF	C	1	2	6	12	14	Vicrita	24	Vicrama	14	Fri	9	29	Th	8	B (4)	46	40	0	6

(*) The upper names, printed in *italics*, are those by the Surriah Siddhanta; the lower ones, printed in roman, are those by the Jyotistava.

I.	II.		III.	IV.	V.		VI.	VII.		VIII.		IX.			X.		XI.	XII.
Christian years.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Cali yug.	Years expired from the birth of Salivahana.	Expired years of the Æra Parasu-rama. Years of the Cycle.	Initial date	Years of the Cycle of 90 Grahaparivrithi.	Years of the Cycle of 60 years or Vrihaspati, Bengal reckoning. Current years.	Numerals.	Years of the Cycle of 60 years as reckoned South of the River Nermada. Current years	Numerals.	Initial feriæ; Tamul civil account N. S.	Date in April N. S.	Date in March O. S.	Initial feriæ of Tamul Sydereal years N. S.	Date in April N. S.	Roots of beginnings of Tamul years counted from Sunday.	Bengalee years called Sen.
						Sep.								Civil			D. G. V. P.	
1701	E	B	4802	1623	877	12	15	C'hara	25	Brisya	15			29	Sat	9	(6) 2 11 15	1107
2	D	A	3	4	8	13	16	Nandana	26	Chitrab'hanu	16			29	Sun	9	(0) 17 42 30	8
3	C	G	4	5	9	13	17	Vijya	27	Súbhánu	17	Tu	10	30	Mo	9	(1) 33 13 45	9
B 4	BA	FE	5	6	880	12	18	Jya	28	Tárana	18	We	9	29	Tu	8	B (2) 48 45 0	1110
5	G	D	6	7	1	12	19	Manmat'ha	29	Párthiva	19			29	Th	9	(4) 4 16 15	1
6	F	C	7	8	2	13	20	Durmuch'ha	30	Vyaya	20			29	Fri	9	(5) 19 47 30	2
7	E	B	8	9	3	13	21	Hemalamva	31	Sarvajit	21	Sun	10	30	Sat	9	(6) 35 18 45	3
B 8	DC	AG	9	1630	4	12	22	Vilamva	32	Sarvadhári	22	Mo	9	29	Sun	8	B (0) 50 50 0	4
9	B	F	4810	1	5	12	23	Vicari	33	Viródhi	23			29	Tu	9	(2) 6 21 15	5
1710	A	E	1	2	6	13	24	Sarvari	34	Vicrita	24			29	We	9	(3) 21 52 30	6
1	G	D	2	3	7	13	25	Plava	35	C'hara	25	Fri	10	30	Th	9	(4) 37 23 45	7
B 2	FE	CB	3	4	8	12	26	Subhacrit	36	Nandana	26	Sat	9	29	Fri	8	B (5) 52 55 0	8
3	D	A	4	5	9	13	27	Sóbhana	37	Vijya	27			29	Sun	9	(0) 8 26 15	9
4	C	G	5	6	890	13	28	Crádhi	38	Jya	28			29	Mo	9	(1) 23 57 30	1120
5	B	F	6	7	1	13	29	Viswávasu	39	Manmat'ha	29	We	10	30	Tu	9	(2) 39 28 45	1
B 6	AG	ED	7	8	2	12	30	Parábhava	40	Durmuch'ha	30	Th	9	29	We	8	B (3) 55 0 0	2
7	F	C	8	9	3	13	31	Plavanga	41	Hemalamva	31			29	Fri	9	(5) 10 31 15	3
8	E	B	9	1640	4	13	32	Cílaca	42	Vilamva	32			29	Sat	9	(6) 25 2 30	4
9	D	A	4820	1	5	13	33	Saumya	43	Vicari	33	Mo	10	30	Sun	9	(0) 41 33 45	5
1720	CB	GF	1	2	6	12	34	Sádhárana	44	Sarvari	34	Tu	9	29	Mo	8	B (1) 57 5 0	6
1	A	E	2	3	7	13	35	Viródhacrit	45	Plava	35			29	We	9	(3) 12 36 15	7
2	G	D	3	4	8	13	36	Paridhávi	46	Subhacrit	36			29	Th	9	(4) 28 7 30	8
3	F	C	4	5	9	13	37	Pramádi	47	Sóbhana	37	Sat	10	30	Fri	9	(5) 43 38 45	9
B 4	ED	BA	5	6	900	12	38	A'nanda	48	Crádhi	38	Sun	9	29	Sat	8	B (6) 59 10 0	1130
5	C	G	6	7	1	13	39	Rac'shasa	49	Viswávasu	39			29	Mo	9	(1) 14 41 15	1
6	B	F	7	8	2	13	40	Anala	50	Parábhava	40	We	10	30	Tu	9	(2) 30 12 30	2
7	A	E	8	9	3	13	41	Pingala	51	Plavanga	41	Th	10	30	We	9	B (3) 45 43 45	3
B 8	GF	DC	9	1650	4	12	42	Cálayucta	52	Cilaca	42			29	Fri	9	(5) 1 15 0	4
9	E	B	4830	1	5	13	43	Sidh'arti	53	Saumya	43			29	Sat	9	(6) 16 46 15	5
1730	D	A	1	2	6	13	44	Raudra	54	Sádhárana	44	Mo	10	30	Sun	9	(0) 32 17 30	6
1	C	G	2	3	7	13	45	Durmati	55	Viródhacrit	45	Tu	10	30	Mo	9	B (1) 47 48 45	7
B 2	BA	FE	3	4	8	13	46	Dundubhi	56	Paridhávi	46			29	We	9	(3) 3 20 0	8
3	G	D	4	5	9	13	47	Rudiródgari	57	Pramádi	47			29	Th	9	(4) 18 51 15	9
4	F	C	5	6	910	13	48	Ractácsha	58	A'nanda	48	Sat	10	30	Fri	9	(5) 34 22 30	1140
5	E	B	6	7	1	13	49	Cródhana	59	Rac'shasa	49	Sun	10	30	Sat	9	B (6) 49 53 45	1
B 6	DC	AG	7	8	2	13	50	Cshya	60	Anala	50			29	Mo	9	(1) 5 25 0	2
7	B	F	8	9	3	13	51	Prabhava (*)	1	Pingala	51			29	Tu	9	(2) 20 56 15	3
8	A	E	9	1660	4	13	52	Vibhava	2	Cálayucta	52	Th	10	30	We	9	(3) 36 27 30	4
9	G	D	4840	1	5	13	53	Sucla	3	Sidh'arti	53	Fri	10	30	Th	9	B (4) 51 58 45	5
1740	FE	CB	1	2	6	13	54	Pramoda	4	Raudra	54			29	Sat	9	(6) 7 30 0	6
1	D	A	2	3	7	13	55	Prajápati	5	Durmati	55			29	Sun	9	(0) 23 1 15	7
2	C	G	3	4	8	13	56	Angira	6	Dundubhi	56	Tu	10	30	Mo	9	(1) 38 32 30	8
3	B	F	4	5	9	13	57	Srimuc'ha	7	Rudiródgari	57	We	10	30	Tu	8	B (2) 54 3 45	9
B 4	AG	ED	5	6	920	13	58	Bhává	8	Ractácsha	58			29	Th	9	(4) 9 35 0	1150
5	F	C	6	7	1	13	59	Yuvá	9	Cródhana	59			29	Fri	9	(5) 25 6 15	1
6	E	B	7	8	2	13	60	Dhátá	10	Cshya	60	Sun	10	30	Sat	9	(6) 40 37 30	2
7	D	A	8	9	3	13	61	Iswara	11	Prabhava (†)	1	Mo	10	30	Sun	9	B (0) 56 8 45	3
B 8	CB	GF	9	1670	4	13	62	Bahudanya	12	Vibhava	2			29	Tu	9	(2) 11 40 0	4
9	A	E	4850	1	5	13	63	Pramát'hi	13	Sucla	3			29	We	9	(3) 27 11 15	5
1750	G	D	1	2	6	13	64	Vicrama	14	Pramoda	4	Fri	10	30	Th	9	(4) 42 42 30	6

(*) Beginning of the 82d Cycle of Jupiter, Surriah Siddhanta.

(†) Beginning of the 82d Cycle, Tellinga account.

First Chronological Table, continued.

I.	II.		III.	IV.	V.		VI	VII.		VIII.		IX.		X.		XI.				XII.
Christian years.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Cali yug.	Years expired from the birth of Salivahana.	Expired years of the Æra Parasurama. Years of the Cycle.	Initial date	Years of the Cycle of 90 Grahaparivrithi.	Years of the Cycle of 60 years or *Vrihaspati*, Bengal reckoning. Current years	Numerals.	Years of the Cycle of 60 years as reckoned South of the River Nermada. Current years.	Numerals.	Initial feriæ; Tamul civil account N. S.	Date in April N. S.	Initial feriæ of Tamul Sydereal years N. S.	Date in April N. S.	Roots of beginnings of Tamul years counted from Sunday,				Bengalee years called Sen.
																D.	G.	V.	P.	
1751	F	C	4852	1673	927	Sep 13	65	Brisya	15	Prajápati	5	Sat	10	Fri	9	B (5)	58	13	45	1157
B 2	FD	BA	3	4	8	13	66	Chitrab'hanu	16	Angira	6			Sun	9	(0)	13	45	0	8
3	C	G	4	5	9	13	67	Súbhána	17	Srimuc'ha	7			Mo	9	(1)	29	16	15	9
4	B	F	5	6	930	13	68	Tárana	18	Bhává	8	We	10	Tu	9	B (2)	44	47	30	1160
5	A	E	6	7	1	13	69	Párthiva	19	Yuvà	9			Th	10	(4)	0	18	45	1
B 6	GF	DC	7	8	2	13	70	Vyaya	20	Dhátá	10			Fri	9	(5)	15	50	0	2
7	E	B	8	9	3	13	71	(*) —— Sarva Sarvad	21 21,22	Iswara	11	Sun	10	Sat	9	(6)	31	21	15	3
8	D	A	9	1680	4	13	72	*Sarvadhari* Virodhi	22 23	Bahudanya	12	Mo	10	Sun	9	B (0)	46	52	30	4
9	C	G	4860	1	5	13	73	*Virodhi* Vicrita	23 24	Pramát'hi	13			Tu	10	(2)	2	23	45	5
1760	BA	FE	1	2	6	13	74	*Vicrita* C'hara	24 25	Vicrama	14			We	9	(3)	17	55	0	6
1	G	D	2	3	7	13	75	*C'hara* Nandana	25 26	Brisya	15	Fri	10	Th	9	(4)	33	26	15	7
2	F	C	3	4	8	13	76	*Nandana* Vijya	26 27	Chitrab'hanu	16	Sat	10	Fri	9	B (5)	46	57	30	8
3	E	B	4	5	9	14	77	*Vijya* Jya	27 28	Súbhánu	17			Sun	10	(0)	4	28	45	9
B 4	DC	AG	5	6	910	13	78	*Jya* Manmat'ha	28 29	Tárana	18			Mo	9	(1)	20	0	0	1170
5	B	F	6	7	1	13	79	*Manmat'ha* Durmuc'ha	29 30	Párthiva	19	We	10	Tu	9	(2)	35	31	15	1
6	A	E	7	8	2	13	80	*Durmuc'ha* Hemalamva	30 31	Vyaya	20	Th	10	We	9	B (3)	51	2	30	2
7	G	D	8	9	3	14	81	*Hemalamva* Vilamva	31 32	Sarvajit	21			Fri	10	(5)	6	33	45	3
B 8	FE	CB	9	1690	4	13	82	*Vilamva* Vicari	32 33	Sarvadhári	22			Sat	9	(6)	22	5	0	4
9	D	A	4870	1	5	13	83	*Vicari* Sarvari	33 34	Viródhi	23	Mo	10	Sun	9	(0)	37	36	15	5
1770	C	G	1	2	6	13	84	*Sarv. Plava* Plava	34,35 35	Vicrita	24	Tu	10	Mo	9	B (1)	53	7	30	6
1	B	F	2	3	7	14	85	Subhacrit	36	C'hara	25			We	10	(3)	8	38	45	7
B 2	AG	ED	3	4	8	13	86	Sóbhana	37	Nandana	26			Th	9	(4)	24	10	0	8
3	F	C	4	5	9	13	87	Crádhi	38	Vijya	27	Sat	10	Fri	9	(5)	39	41	15	9
4	E	B	5	6	950	13	88	Viswávasù	39	Jya	28	Sun	10	Sat	9	B (6)	55	12	30	1180
5	D	A	6	7	1	14	89	Parábhava	40	Manmat'ha	29			Mo	10	(1)	10	43	45	1
B 6	CB	GF	7	8	2	13	90	Plavanga	41	Durmuc'ha	30			Tu	9	(2)	26	15	0	2
7	A	E	8	9	2 3	14 13	Cycle 1	Cílaca	42	Hemalamva	31	Th	10	We	8	(3)	41	46	15	3
8	G	D	9	1700	4	13	2	Saumya	43	Vilamva	32	Fri	10	Th	9	B (4)	57	17	30	4
9	F	C	4880	1	5	14	3	Sádhárana	44	Vicári	33			Sat	10	(6)	12	48	45	5
1780	ED	BA	1	2	6	13	4	Viródhacrit	45	Sarvari	34			Sun	9	(0)	28	20	0	6
1	C	G	2	3	7	13	5	Paridhávi	46	Plava	35	Tu	10	Mo	9	(1)	43	51	15	7
2	B	F	3	4	8	13	6	Pramádi	47	Subhacrit	36	We	10	Tu	9	B (2)	59	22	30	8
3	A	E	4	5	9	14	7	A'nanda	48	Sóbhana	37			Th	10	(4)	14	53	45	9
B 4	GF	DC	5	6	960	13	8	Rác'shasa	49	Crádhi	38	Sat	10	Fri	9	(5)	30	25	0	1190
5	E	B	6	7	1	13	9	Anala	50	Viswávasù	39	Sun	10	Sat	9	B (6)	45	56	15	1
6	D	A	7	8	2	13	10	Pingala	51	Parábhava	40			Mo	10	(1)	1	27	30	2
7	C	G	8	9	3	14	11	Cálayucta	52	Plavanga	41			Tu	10	(2)	16	58	45	3
B 8	BA	FE	9	1710	4	13	12	Sidh'arti	53	Cilaca	42	Th	10	We	9	(3)	32	30	0	4
9	G	D	4890	1	5	13	13	Raudra	54	Saumya	43	Fri	10	Th	9	B (4)	48	1	15	5
1790	F	C	1	2	6	14	14	Durmati	55	Sádhárana	44			Sat	10	(6)	8	32	30	6
1	E	B	2	3	7	14	15	Dundubhi	56	Viródhacrit	45			Sun	10	(0)	19	3	45	7
B 2	DC	AG	3	4	8	13	16	Rudiródgari	57	Paridhávi	46	Tu	10	Mo	9	(1)	34	35	0	8
3	B	F	4	5	9	13	17	Ractácsha	58	Pramádi	47	We	10	Tu	9	B (2)	50	6	15	9
4	A	E	5	6	970	14	18	Cródhana	59	A'nanda	48			Th	10	(4)	5	37	30	1200
5	G	D	6	7	1	14	19	Cshya	60	Rac'shasa	49			Fri	10	(5)	21	8	45	1
B 6	FE	CB	7	8	2	13	20	Prabhava(†)	1	Anala	50	Sun	10	Sat	9	(6)	36	40	0	2
7	D	A	8	9	3	13	21	Vibhava	2	Pingala	51	Mo	10	Sun	9	B (0)	52	11	15	3
8	C	G	9	1720	4	14	22	Sucla	3	Cálayucta	52			Tu	10	(2)	7	42	30	4
9	B	F	4900	1	5	14	23	Pramoda	4	Sid'harti	53			We	10	(3)	23	13	45	5
1800	AG	E	1	2	6	14	24	Prajápati	5	Raudra	54	Fr	11	Th	10	(4)	38	45	0	6

(*) The upper names, printed in *italics*, are those by the Surriah Siddhanta; the lower ones, printed in roman, are those by the Jyautistava.

(†) Beginning of the 84th Cycle of Jupiter, Surriah Siddhanta.

I.	II.		III.	IV.	V.		VI.	VII.		VIII.		IX.		X.		XI.					XII.
Christian years.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Cali yug.	Years expired from the birth of Salivahana.	Expired years of the Æra Parasu-rama. Years of the Cycle.	Initial date	Years of the Cycle of 90 Grahaparivrithi	Years of the Cycle of 60 years or *Vrihaspati*, Bengal reckoning. Current years.	Numerals.	Years of the Cycle of 60 years as reckoned South of the River Nermada. Current years	Numerals.	Initial feriæ; Tamul civil account N. S.	Date in April N. S.	Initial feriæ of Tamul Sydereal years N. S.	Date in April N. S.	Roots of beginnings of Tamul years counted from Sunday.					Bengalee years called Sen.
						Sep.											D.	G.	V.	P.	
1801	F	D	1902	1723	977	14	25	Angira	6	Durmati	55	Sat	11	Fri	10	B	(5)	54	16	15	1207
2	E	C	3	4	8	15	26	Srimuc'ha	7	Dundubhi	56			Sun	11		(0)	9	47	30	8
3	D	B	4	5	9	15	27	Bháva	8	Rudiródgari	57			Mo	11		(1)	25	18	45	9
B 4	CB	AG	5	6	980	14	28	Yuvá	9	Ractácsha	58	We	11	Tu	10		(2)	40	50	0	1210
5	A	F	6	7	1	14	29	Dhátá	10	Cródhana	59	Th	11	We	10	B	(3)	56	21	15	1
6	G	E	7	8	2	15	30	Iswara	11	Cshya	60			Fri	11		(5)	11	52	30	2
7	F	D	8	9	3	15	31	Bahudanya	12	Prabhava(+)	1			Sat	11		(6)	27	23	45	3
B 8	ED	CB	9	1730	4	14	32	Pramát'hi	13	Vibhava	2	Mo	11	Sun	10		(0)	42	55	0	4
9	C	A	1910	1	5	14	33	Vicrama	14	Sucla	3	Tu	11	Mo	10	B	(1)	58	26	15	5
1810	B	G	1	2	6	15	34	Brisya	15	Pramoda	4			We	11		(3)	13	57	30	6
1	A	F	2	3	7	15	35	Chitrab'hanu	16	Prajápati	5			Th	11		(4)	29	28	45	7
B 2	GF	ED	3	4	8	14	36	Súbhánu	17	Angira	6	Sat	11	Fri	10	B	(5)	45	0	0	8
3	E	C	4	5	9	14	37	Tárana	18	Srimuc'ha	7			Sun	11		(0)	0	31	15	9
4	D	B	5	6	990	15	38	Párthiva	19	Bhává	8			Mo	11		(1)	16	2	30	1220
5	C	A	6	7	1	15	39	Vyaya	20	Yuvá	9	We	12	Tu	11		(2)	31	33	45	1
B 6	BA	GF	7	8	2	14	40	Sarvajit	21	Dhátá	10	Th	11	We	10	B	(3)	47	5	0	2
7	G	E	8	9	3	14	41	Sarvadhári	22	Iswara	11			Fri	11		(5)	2	36	15	3
8	F	D	9	1740	4	15	42	Viródhi	23	Bahudanya	12			Sat	11		(6)	18	7	30	4
9	E	C	4920	1	5	15	43	Vicrita	24	Pramát'hi	13	Mo	12	Sun	11		(0)	33	38	45	5
1820	DC	BA	1	2	6	14	44	C'hara	25	Vicrama	14	Tu	11	Mo	10	B	(1)	49	10	0	6
1	B	G	2	3	7	15	45	Nandana	26	Brisya	15			We	11		(3)	4	41	15	7
2	A	F	3	4	8	15	46	Vijya	27	Chitrab'hanu	16			Th	11		(4)	20	12	30	8
3	G	E	4	5	9	15	47	Jya	28	Súbhánu	17	Sat	12	Fri	11		(5)	35	43	45	9
B 4	FE	DC	5	6	1000	14	48	Manmat'ha	29	Tárana	18	Sun	11	Sat	10	B	(6)	51	15	0	1230
5	D	B	6	7	1	15	49	Durmuch'ha	30	Párthiva	19			Mo	11		(1)	6	46	15	1
6	C	A	7	8	2	15	50	Hemalamva	31	Vyaya	20			Tu	11		(2)	22	17	30	2
7	B	G	8	9	3	15	51	Vilamva	32	Sarvajit	21	Th	12	We	11		(3)	37	48	45	3
B 8	AG	FE	9	1750	4	14	52	Vicari	33	Sarvadhári	22	Fri	11	Th	10	B	(4)	53	20	0	4
9	F	D	4930	1	5	15	53	Sarvari	34	Viródhi	23			Sat	11		(6)	8	51	15	5
1830	E	C	1	2	6	15	54	Plava	35	Vicrita	24			Sun	11		(0)	24	22	30	6
1	D	B	2	3	7	15	55	Subhacrit	36	C'hara	25	Tu	12	Mo	11		(1)	39	53	45	7
B 2	CB	AG	3	4	8	14	56	Sóbhana	37	Nandana	26	We	11	Tu	10	B	(2)	55	25	0	8
3	A	F	4	5	9	15	57	Crádhi	38	Vijya.	27			Th	11		(4)	10	56	15	9
4	G	E	5	6	10	15	58	Viswávasù	39	Jya	28			Fri	11		(5)	26	27	30	1240
5	F	D	6	7	11	15	59	Parábhava	40	Manmat'ha	29	Sun	12	Sat	11		(6)	41	58	45	1
B 6	ED	CB	7	8	12	14	60	Plavanga	41	Durmuch'ha	30	Mo	11	Sun	10	B	(0)	57	30	0	2
7	C	A	8	9	13	15	61	Cílaca	42	Hemalamva	31			Tu	11		(2)	13	1	15	3
8	B	G	9	1760	14	15	62	Saumya	43	Vilamva	32			We	11		(3)	28	32	30	4
9	A	F	4940	1	15	15	63	Sádhárana	44	Vicari	33	Fri	12	Th	11		(4)	44	3	45	5
1840	GF	ED	1	2	16	14	64	Viródhacrit	45	Sarvari	34	Sat	11	Fri	10	B	(5)	59	35	0	6
1	E	C	2	3	17	15	65	Paridhávi	46	Plava	35			Sun	11		(0)	15	6	15	7
2	D	B	3	4	18	15	66	Pramádi	47	Subhacrit	36	Tu	12	Mo	11		(1)	30	37	30	8
3	C	A	4	5	19	15	67	(*) —— Anan. Racsh	48 48,49	Sóbhana,	37	We	12	Tu	11	B	(2)	46	3	45	9
B 4	BA	GF	5	6	20	14	68	*Racshasa* Anala	49 50	Crádhi	38			Th	11		(4)	1	40	0	1250
5	G	E	6	7	21	15	69	*Anala* Pingala	50 51	Viswávasù	39			Fri	11		(5)	17	11	15	1
6	F	D	7	8	22	15	70	*Pingala* Calayucta	51 52	Parábhava	40	Sun	12	Sat	11		(6)	32	42	30	2
7	E	C	8	9	23	15	71	*Calayucta* Sidharti	52 53	Plavanga	41	Mo	12	Sun	11	B	(0)	48	13	45	3
B 8	DC	BA	9	1770	24	15	72	*Sidharti* Raudra	53 54	Cílaca	42			Tu	11		(2)	3	45	0	4
9	B	G	4950	1	25	15	73	*Raudra* Durmati	54 55	Saumya	43			We	11		(3)	19	13	15	5
1850	A	F	1	2	26	15	74	*Durmati* Dundubhi	55 56	Sádhárana	44	Fri	12	Th	11		(4)	34	47	30	6

(*) The upper names, printed in *italics*, are those by the Surriah Siddhanta; the lower ones, printed in roman, are those by the Jyautishas.

(+) Beginning of the 83d Cycle of Jupiter, Tellinga account.

I.	II.		III.	IV.	V.		VI.	VII.		VIII.		IX.		X.		XI.				XII.
Christian years.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Cali yug.	Years expired from the birth of Salivahana.	Expired years of the Æra Parasu-rama. Years of the Cycle.	Initial date	Years of the Cycle of 90 Grahaparivritti.	Years of the Cycle of 60 years or Vrihaspati, Bengal reckoning. Current years.	Numerals.	Years of the Cycle of 60 years as reckoned South of the River Nerma-da. Current years	Numerals.	Initial feriæ, Tamul civil account N. S.	Date in April N. S.	Initial feriæ of Tamul Syderal years N. S.	Date in April N. S.	Roots of beginnings of Tamul years counted from Sunday.				Bengalee years called Sen.
						Sep.										D.	G.	V.	P.	
1851	G	E	4952	1773	27	15	75	*Dundubhi* Rudiródgari	56 57	Viródhacrit	45	Sat	12	Fri	11	B (5)	50	13	45	1257
B 2	FE	DC	3	4	28	15	76	*Rudiródgari* Ractacsha	57 58	Paridhári	46			Sun	11	(0)	5	50	0	8
3	D	B	4	5	29	15	77	*Ractácsha* Crodhana	58 59	Pramádi	47			Mo	11	(1)	21	21	15	9
4	C	A	5	6	30	15	78	*Cródhana* Cshya	59 60	A'nanda	48	We	12	Tu	11	(2)	36	52	30	1260
5	B	G	6	7	31	15	79	*Cshya* Prabhava	60 1	Rac'shasa	49	Th	12	We	11	B (3)	52	23	45	1
B 6	AG	FE	7	8	32	15	80	*Prabh. Vibh.* Vibhava	+1.2 2	Anala	50			Fri	11	(5)	7	55	0	2
7	F	D	8	9	33	15	81	Sucla	3	Pingala	51			Sat	11	(6)	23	26	15	3
8	E	C	9	1780	34	15	82	Pramoda	4	Cálayucta	52	Mo	12	Sun	11	(0)	38	57	30	4
9	D	B	4960	1	35	15	83	Prajápati	5	Sidh'arti	53	Tu	12	Mo	11	B (1)	54	28	45	5
1860	CB	AG	1	2	36	15	84	Angira	6	Raudra	54			We	11	(3)	10	0	0	6
1	A	F	2	3	37	15	85	Srimuc'ha	7	Durmati	55			Th	11	(4)	25	31	15	7
2	G	E	3	4	38	15	86	Bháva	8	Dundubhi	56	Sat	12	Fri	11	(5)	41	2	30	8
3	F	D	4	5	39	15	87	Yuvá	9	Rudiródgari	57	Sun	12	Sat	11	B (6)	56	83	45	9
B 4	ED	CB	5	6	40	15	88	Dhátá	10	Ractacsha	58			Mo	11	(1)	12	5	0	1270
5	C	A	6	7	41	15	89	Iswara	11	Cródhana	59			Tu	11	(2)	27	36	15	1
6	B	G	7	8	42	15	90	Bahudanya	12	Cshya	60	Th	12	We	11	(3)	43	7	30	2
						2d	Cycle													
7	A	F	8	9	43	15	1	Pramát'hi	13	Prabhava(‡)	1	Fri	12	Th	11	B (4)	58	38	45	3
B 8	GF	ED	9	1790	44	15	2	Vicrama	14	Vibhava	2			Sat	11	(6)	14	10	0	4
9	E	C	4970	1	45	15	3	Brisya	15	Sucla	3			Sun	11	(0)	29	41	15	5
1870	D	B	1	2	46	15	4	Chitrab'hanu	16	Pramoda	4	Tu	12	Mo	11	B (1)	45	12	30	6
1	C	A	2	3	47	15	5	Súbhánu	17	Prajápati	5			We	12	(3)	0	43	45	7
B 2	BA	GF	3	4	48	15	6	Tárana	18	Angira	6			Th	11	(4)	16	15	0	8
3	G	E	4	5	49	15	7	Párthiva	19	Srimuc'ha	7	Sat	12	Fri	11	(5)	31	46	15	9
4	F	D	5	6	50	15	8	Vyaya	20	Bhává	8	Sun	12	Sat	11	B (6)	47	17	30	1280
5	E	C	6	7	51	15	9	Sarvajit	21	Yuva	9			Mo	12	(1)	2	48	45	1
B 6	DC	BA	7	8	52	15	10	Sarvadhári	22	Dhátá	10			Tu	11	(2)	18	20	0	2
7	B	G	8	9	53	15	11	Viródhi	23	Iswara	11	Th	12	We	11	(3)	33	51	15	3
8	A	F	9	1800	54	15	12	Vicrita	24	Bahudanya	12	Fri	12	Th	11	B (4)	49	22	30	4
9	G	E	4980	1	55	16	13	C'hara	25	Pramát'hi	13			Sat	12	(6)	4	53	45	5
1880	FE	DC	1	2	56	15	14	Nandana	26	Vicrama	14			Sun	11	(0)	20	25	0	6
1	D	B	2	3	57	15	15	Vijya	27	Brisya	15	Tu	12	Mo	11	(1)	35	56	15	7
2	C	A	3	4	58	15	16	Jya	28	Chitrab'hanu	16	We	12	Tu	11	B (2)	51	27	30	8
3	B	G	4	5	59	16	17	Manmat'ha	29	Súbhánu	17			Th	12	(4)	6	58	45	9
B 4	AG	FE	5	6	60	15	18	Durmuch'ha	30	Tárana	18			Fri	11	(5)	22	30	0	1290
5	F	D	6	7	61	15	19	Hemalamva	31	Párthiva	19	Sun	12	Sat	11	(6)	38	1	15	1
6	E	C	7	8	62	15	20	Vilamva	32	Vyaya	20	Mo	12	Sun	11	B (0)	53	32	30	2
7	D	B	8	9	63	16	21	Vicari	33	Sarvajit	21			Tu	12	(2)	9	3	45	3
B 8	CB	AG	9	1810	64	15	22	Sarvari	34	Sarvadhári	22			We	11	(3)	24	35	0	4
9	A	F	4990	1	65	15	23	Plava	35	Viródhi	23	Fri	12	Th	11	(4)	40	6	15	5
1890	G	E	1	2	66	15	24	Subhacrit	36	Vicrita	24	Sat	12	Fri	11	B (5)	55	37	30	6
1	F	D.	2	3	67	16	25	Sóbhana	37	C'hara	25			Sun	12	(0)	11	8	45	7
B 2	ED	CB	3	4	68	15	26	Crádhi	38	Nandana	26			Mo	11	(1)	26	40	0	8
3	C	A	4	5	69	15	27	Viswávasù	39	Vijya	27	We	12	Tu	11	(2)	42	11	15	9
4	B	G	5	6	70	15	28	Parábhava	40	Jya	28	Th	12	We	11	B (3)	57	42	30	1300
5	A	F	6	7	71	16	29	Plavanga	41	Manmat'ha	29			Fri	12	(5)	13	13	45	1
B 6	GF	ED	7	8	72	15	30	Cílaca	42	Durmuc'ha	30			Sat	11	(6)	28	45	0	2
7	E	C	8	9	73	15	31	Saumya	43	Hemalamva	31	Mo	12	Sun	11	(0)	44	16	15	3
8	D	B	9	1820	74	15	32	Sádharana	44	Vilamva	32	Tu	12	Mo	11	B (1)	59	47	30	4
9	C	A	5000	1	75	16	33	Viródhacrit	45	Vicári	33			We	12	(3)	15	18	45	5
1900	BA	G	1	2	76	16	34	Paridhávi	46	Sarvari	34	Fri	13	Th	12	(4)	30	50	0	6

(*) The upper names, printed in *italics*, are those by the Surriah Siddhanta; the lower ones, printed in roman, are those by the Jyautistava.

(+) Beginning of the 85th Cycle of Jupiter, Surriah Siddhanta.

(‡) Beginning of the 84th Cycle, Tellinga account.

SECOND CHRONOLOGICAL TABLE *shewing the principal circumstances of the common Luni-solar year in use in the Peninsula of India, and the concurring Fuzelee or revenue years.*

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.				X.	XI.	XII.		
Christian years.	Years expired of the Cali yug	Character of the year.	Last feria in the Luni-solar year.	Date of the last mean conjunction in do.	Date in Chitra of Solar year.	Sydereal duration of Chitra.	Civil duration of Chitra.	Solar Ahargana, or Yugadin, to be counted from Friday.				Luni-solar Ahargana to be counted from Thursday.	Years of Æra Vicramaditya.	Fuzelee years expired.	Initial date, O. S.	Initial date, N. S.
					(*)			DAYS.	G.	V.	P.	DAYS.			June July	July
B 1600	4701	A	Wednes	15 Mar	—9	30	30	1717078	54	35	0	1717057	1657	1009	30	10
1	2		Monday	2 April	—27	31	30	1717444	10	6	15	1717440	8	1010	30	10
2	3		Saturday	23 Mar	16	30	30	1717809	25	37	30	1717795	9	1	30	10
3	4	A	Wednes	12 Mar	5	30	31	1718174	41	8	45	1718119	1660	2	1	11
B 4	5		Tuesday	30 Mar	—24	30	30	1718539	56	40	0	1718533	1	3	30	10
5	6	A	Saturday	19 Mar	—13	31	30	1718905	12	11	15	1718887	2	4	30	10
6	7		Thursday	9 Mar	2	30	30	1719270	27	42	30	1719212	3	5	30	10
7	8		Wednes	28 Mar	21	30	31	1719635	43	13	45	1719626	4	6	1	11
B 8	9	A	Sunday	16 Mar	—10	30	30	1720000	58	45	0	1719950	5	7	30	10
9	4710		Saturday	4 April	—29	31	30	1720366	14	16	15	1720364	6	8	30	10
1610	1		Wednes	24 Mar	17	30	30	1720731	29	47	30	1720718	7	9	30	10
1	2	A	Monday	14 Mar	7	30	31	1721096	45	18	45	1721073	8	1020	1	11
B 2	3		Sunday	1 April	—26	31	30	1721462	0	50	0	1721457	9	1	30	10
3	4	A	Thursday	21 Mar	—15	31	30	1721827	16	21	15	1721811	1670	2	30	10
4	5		Monday	10 Mar	3	30	31	1722192	31	52	30	1722165	1	3	30	10
5	6		Sunday	29 Mar	22	30	31	1722557	47	23	45	1722549	2	4	1	11
B 6	7	A	Friday	18 Mar	—12	31	30	1722923	2	55	0	1722904	3	5	30	10
7	8		Wednes	5 April	—30	31	30	1723288	18	26	15	1723287	4	6	30	10
8	9		Monday	26 Mar	19	30	31	1723653	33	57	30	1723642	5	7	1	11
9	4720	A	Friday	15 Mar	8	30	31	1724018	49	28	45	1723996	6	8	1	11
B 1620	1		Thursday	2 April	—27	31	30	1724384	5	0	0	1724380	7	9	30	10
1	2		Monday	22 Mar	15	30	30	1724749	20	31	15	1724734	8	1030	30	10
2	3	A	Saturday	12 Mar	5	30	31	1725114	36	2	30	1725089	9	1	1	11
3	4		Friday	31 Mar	24	30	31	1725479	51	33	45	1725473	1680	2	1	11
B 4	5	A	Tuesday	19 Mar	—13	31	30	1725845	7	5	0	1725827	1	3	30	10
5	6		Saturday	8 Mar	1	30	30	1726210	22	36	15	1726181	2	4	30	10
6	7		Friday	27 Mar	20	30	31	1726575	38	7	30	1726565	3	5	1	11
7	8	A	Wednes	17 Mar	—10	30	30	1726940	53	38	45	1726920	4	6	1	11
B 8	9		Tuesday	4 April	—29	31	30	1727306	9	10	0	1727304	5	7	30	10
9	4730		Saturday	24 Mar	17	30	30	1727671	24	41	15	1727658	6	8	30	10
1630	1	A	Wednes	13 Mar	6	30	31	1728036	40	12	30	1728012	7	9	1	11
1	2		Tuesday	1 April	—25	30	30	1728401	55	43	45	1728396	8	1040	1	11
B 2	3	A	Sunday	21 Mar	—15	31	30	1728767	11	15	0	1728751	9	1	30	10
3	4		Thursday	10 Mar	3	30	30	1729132	26	46	15	1729105	1690	2	30	10
4	5		Wednes	29 Mar	22	30	31	1729497	42	17	30	1729489	1	3	1	11
5	6	A	Sunday	18 Mar	—11	30	30	1729862	57	48	45	1729843	2	4	1	11
B 6	7		Saturday	5 April	—30	31	30	1730228	13	20	0	1730227	3	5	30	10
7	8		Thursday	26 Mar	19	30	30	1730593	28	51	15	1730582	4	6	30	10
8	9	A	Monday	15 Mar	8	30	31	1730958	44	22	30	1730936	5	7	1	11
9	4740		Sunday	3 April	—27	30	30	1731323	59	53	45	1731320	6	8	1	11
B 1640	1		Thursday	22 Mar	—16	31	30	1731689	15	25	0	1731674	7	9	30	10
1	2	A	Tuesday	12 Mar	5	30	31	1732054	30	56	15	1732029	8	1050	30	10
2	3		Sunday	30 Mar	23	30	31	1732419	46	27	30	1732412	9	1	1	11
3	4	A	Friday	20 Mar	—13	31	30	1732785	1	58	45	1732767	1700	2	1	11
B 4	5		Thursday	8 Mar	—2	31	30	1733150	17	30	0	1733121	1	3	30	10
5	6		Monday	27 Mar	20	30	31	1733515	33	1	15	1733505	2	4	30	10
6	7	A	Friday	16 Mar	9	30	31	1733880	48	32	30	1733859	3	5	1	11
7	8		Thursday	4 April	—28	31	30	1734246	4	3	45	1734243	4	6	1	11
B 8	9		Tuesday	24 Mar	—18	31	30	1734611	19	35	0	1734598	5	7	30	10
9	4750	A	Saturday	13 Mar	6	30	31	1734976	35	6	15	1734952	6	8	1	11
1650	1		Friday	1 April	—25	30	30	1735341	50	37	30	1735336	7	9	1	11

(*) The stroke — before the figure, indicates that the *Civil* Solar date is one less.

Second Chronological Table, continued.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.				X.	XI.	XII.		
Christian years.	Years expired of the Cali yug	Character of the year.	Last feria in the Luni-solar year.	Date of the last mean conjunction in do.	Date in Chitra of Solar year.	Sydereal duration of Chitra.	Civil duration of Chitra.	Solar Ahargana, or Yugadia, to be counted from Friday.				Luni-solar Ahargana to be counted from Thursday.	Years of Æra Vicramaditya.	Puzelee years expired.	Initial date, U. S.	Initial date, N. S.
					Syd.			DAYS.	G.	V.	P.	DAYS.			June July	July
1651	4752	A	Tuesday	21 Mar	—14	31	30	1735707	6	8	45	1735690	1708	1060	1	11
B 2	3		Sunday	10 Mar	3	30	30	1736072	27	40	0	1736045	9	1	30	10
3	4		Saturday	29 Mar	22	30	31	1736437	37	11	15	1736420	1710	2	1	11
4	5	A	Wednes	18 Mar	—11	30	30	1736802	52	42	30	1736783	1	3	1	11
5	6		Tuesday	6 April	—30	31	30	1737168	8	13	45	1737167	2	4	1	11
B 6	7		Saturday	25 Mar	18	30	30	1737533	23	45	0	1737521	3	5	30	10
7	8	A	Thursday	15 Mar	8	30	31	1737898	39	16	15	1737876	4	6	1	11
8	9		Tuesday	2 April	—26	30	30	1738263	54	47	30	1738259	5	7	1	11
9	4760		Sunday	23 Mar	—16	31	30	1738629	10	18	45	1738614	6	8	1	11
B 1660	1	A	Thursday	11 Mar	4	30	30	1738994	25	50	0	1738968	7	9	30	10
1	2		Wednes	30 Mar	23	30	31	1739359	41	21	15	1739352	8	1070	1	11
2	3	A	Sunday	19 Mar	—12	30	30	1739724	56	52	30	1739706	9	1	1	11
3	4		Saturday	7 April	—31	31	30	1740090	12	23	45	1740090	1720	2	1	11
B 4	5		Thursday	27 Mar	20	30	30	1740455	27	55	0	1740445	1	3	30	10
5	6	A	Monday	16 Mar	9	30	31	1740820	43	26	15	1740799	2	4	1	11
6	7		Sunday	4 April	—28	30	30	1741185	58	57	30	1741183	3	5	1	11
7	8		Thursday	24 Mar	—17	31	30	1741551	14	28	45	1741537	4	6	1	11
B 8	9	A	Tuesday	13 Mar	6	30	31	1741916	30	0	0	1741892	5	7	30	10
9	4770		Monday	1 April	25	30	31	1742281	45	31	15	1742276	6	8	1	11
1670	1	A	Friday	21 Mar	—14	31	30	1742647	1	2	30	1742630	7	9	1	11
1	2		Tuesday	10 Mar	— 3	31	30	1743012	16	33	45	1742984	8	1080	1	11
B 2	3		Monday	28 Mar.	21	30	31	1743377	32	5	0	1743368	9	1	30	10
3	4	A	Saturday	18 Mar	11	30	31	1743742	47	36	15	1743723	1730	2	1	11
4	5		Friday	6 April	—30	31	30	1744108	3	7	30	1744107	1	3	1	11
5	6		Tuesday	26 Mar	—19	31	30	1744473	18	38	45	1744461	2	4	1	11
B 6	7	A	Saturday	14 Mar	7	30	31	1744838	34	10	0	1744815	3	5	1	11
7	8		Friday	2 April	26	30	31	1745203	49	41	15	1745199	4	6	1	11
8	9		Wednes	23 Mar	—16	31	30	1745569	5	12	30	1745554	5	7	1	11
9	4780	A	Sunday	12 Mar	4	30	30	1745934	20	43	45	1745908	6	8	1	11
B 1680	1	(*)	Saturday	30 Mar	23	30	31	1746299	36	15	0	1746292	7	9	1	11
1	2	AC	Wednes	19 Mar	—12	30	30	1746664	51	46	15	1746646	8	1090	1	11
2	3		Tuesday	7 April	—31	31	30	1747030	7	17	30	1747030	9	1	1	11
3	4		Saturday	27 Mar	19	30	30	1747395	22	48	45	1747384	1740	2	1	11
B 4	5	A	Thursday	16 Mar	9	30	31	1747760	38	20	0	1747759	1	3	1	11
5	6		Wednes	4 April	—28	30	30	1748125	53	51	15	1748123	2	4	1	11
6	7		Sunday	24 Mar	—17	31	30	1748491	9	22	30	1748477	3	5	1	11
7	8	A	Thursday	13 Mar	5	30	30	1748856	24	53	45	1748831	4	6	1	11
B 8	9		Wednes	31 Mar	24	30	31	1749221	40	25	0	1749215	5	7	1	11
9	4790	A	Monday	21 Mar	—14	30	30	1749586	55	56	15	1749570	6	8	1	11
1690	1		Friday	10 Mar	— 3	31	30	1749952	11	27	30	1749924	7	9	1	11
1	2		Thursday	29 Mar	21	30	30	1750317	26	58	45	1750308	8	1100	1	11
B 2	3	A	Monday	17 Mar	10	30	31	1750682	42	30	0	1750662	9	1	1	11
3	4		Sunday	5 April	—29	30	30	1751047	58	1	15	1751046	1750	2	1	11
4	5		Friday	26 Mar	—19	31	30	1751413	13	32	30	1751401	1	3	1	11
5	6	A	Tuesday	15 Mar	7	30	30	1751778	29	3	45	1751755	2	4	1	11
B 6	7		Monday	2 April	26	30	31	1752143	44	35	0	1752139	3	5	1	11
7	8	A	Friday	22 Mar	—15	31	30	1752509	0	6	15	1752493	4	6	1	11
8	9		Wednes	12 Mar	— 5	31	30	1752874	15	37	30	1752848	5	7	1	11
9	1800		Tuesday	31 Mar	23	30	31	1753239	31	8	45	1753232	6	8	1	11
1700	1	A	Saturday	20 Mar.	12	30	31	1753604	46	40	0	1753586	7	9	1	12

(*) The expunged month in the 4783d year of the Cali yug current, fell on Agrahayan otherwise Margasiras, and the intercalated months were Aswina and Chitra, of the ensuing year.

Second Chronological Table, continued.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.				X.	XI.	XII.		
Christian years.	Years expired of the Cali yug.	Character of the year.	Last feria in the Luni-solar year.	Date of the last mean conjunction in do.	Date in Chitra of Solar year.	Sydereal duration of Chitra.	Civil duration of Chitra.	Solar Ahargana, or Yugadin, to be counted from Friday.				Luni-solar Ahargana to be counted from Thursday.	Years of Æra Vicramaditya.	Fuzelee years expired.	Initial date, O. S.	Initial date, N. S.
						Syd.		DAYS.	G.	V.	P.	DAYS.			July	July
1701	4802		Friday	8 April	—31	31	30	1753970	2	11	15	1753970	1758	1110	1	12
2	3		Tuesday	28 Mar	—20	31	30	1754335	17	42	30	1754321	9	1	1	12
3	4	A	Saturday	17 Mar	8	30	31	1754700	33	13	45	1754678	1760	2	1	12
4	5		Friday	4 April	27	30	31	1755065	48	45	0	1755062	1	3	1	12
5	6		Wednes	25 Mar	—17	31	30	1755431	4	16	15	1755417	2	4	1	12
6	7	A	Sunday	14 Mar	— 6	31	30	1755796	19	47	30	1755771	3	5	2	13
7	8		Saturday	2 April	24	30	31	1756161	35	18	45	1756155	4	6	1	12
8	9	A	Wednes	21 Mar	—13	30	30	1756526	50	50	0	1756509	5	7	1	12
9	4810		Monday	11 Mar	— 3	31	30	1756892	6	21	15	1756864	6	8	1	12
1710	1		Saturday	29 Mar	20	30	30	1757257	21	52	30	1757247	7	9	1	12
1	2	A	Thursday	19 Mar	10	30	31	1757622	37	23	45	1757602	8	1120	2	13
2	3		Wednes	6 April	—29	30	30	1757987	52	55	0	1757986	9	1	1	12
3	4		Sunday	26 Mar	—18	31	30	1758353	8	26	15	1758340	1770	2	1	12
4	5	A	Thursday	15 Mar	6	30	30	1758718	23	57	30	1758694	1	3	1	12
5	6		Wednes	3 April	25	30	31	1759083	39	28	45	1759078	2	4	2	13
6	7	A	Monday	23 Mar	—15	30	30	1759448	55	0	0	1759433	3	5	1	12
7	8		Friday	12 Mar	— 4	31	30	1759814	10	31	15	1759787	4	6	1	12
8	9		Thursday	31 Mar	22	30	30	1760179	26	2	30	1760171	5	7	1	12
9	4820	A	Tuesday	21 Mar	11	30	31	1760544	41	33	45	1760525	6	8	2	13
1720	1		Saturday	9 Mar	— 1	30	30	1760909	57	5	0	1760880	7	9	1	12
1	2		Friday	28 Mar	—20	31	30	1761275	12	36	15	1761264	8	1130	1	12
2	3	A	Tuesday	17 Mar	8	30	30	1761640	28	7	30	1761618	9	1	1	12
3	4		Monday	5 April	27	30	31	1762005	43	38	45	1762002	1780	2	2	13
4	5		Friday	24 Mar	—16	30	30	1762370	59	10	0	1762356	1	3	1	12
5	6	A	Wednes	14 Mar	— 6	31	30	1762736	14	41	15	1762711	2	4	1	12
6	7		Tuesday	2 April	24	30	31	1763101	30	12	30	1763095	3	5	1	12
7	8	A	Saturday	22 Mar	13	30	31	1763466	45	43	45	1763449	4	6	2	13
8	9		Wednesd	10 Mar	— 2	31	30	1763832	1	15	0	1763803	5	7	1	12
9	4830		Tuesday	29 Mar	—21	31	30	1764197	16	46	15	1764187	6	8	1	12
1730	1	A	Sunday	19 Mar	10	30	31	1764562	32	17	30	1764542	7	9	1	12
1	2		Friday	9 April	28	30	31	1764927	47	48	45	1764925	8	1140	2	13
2	3		Wednes	26 Mar	—18	31	30	1765293	3	20	0	1765280	9	1	1	12
3	4	A	Sunday	15 Mar	— 7	31	30	1765658	18	51	15	1765634	1790	2	1	12
4	5		Saturday	3 April	25	30	31	1766023	34	22	30	1766018	1	3	2	12
5	6	A	Wednes	23 Mar	14	30	31	1766388	49	53	45	1766372	2	4	2	13
6	7		Monday	12 Mar	— 4	31	30	1766754	5	25	0	1766727	3	5	1	12
7	8		Sunday	31 Mar	22	30	30	1767119	20	56	15	1767111	4	6	1	12
8	9	A	Thursday	20 Mar	11	30	31	1767484	36	27	30	1767465	5	7	2	13
9	4840		Wednes	8 April	—30	30	30	1767849	51	58	45	1767849	6	8	2	13
1740	1		Sunday	27 Mar	—19	31	30	1768215	7	30	0	1768203	7	9	1	12
1	2	A	Friday	17 Mar	8	30	30	1768580	23	1	15	1768558	8	1150	1	12
2	3		Thursday	5 April	27	30	31	1768945	38	32	30	1768942	9	1	2	13
3	4		Monday	25 Mar	—16	30	30	1769310	54	3	45	1769296	1800	2	2	13
4	5	A	Friday	13 Mar	— 5	31	30	1769676	9	35	0	1769650	1	3	1	12
5	6		Thursday	1 April	23	30	30	1770041	25	6	15	1770034	2	4	1	12
6	7	A	Tuesday	22 Mar	13	30	31	1770406	40	37	30	1770389	3	5	2	13
7	8		Saturday	11 Mar	— 2	30	30	1770771	56	8	45	1770743	4	6	2	13
8	9		Friday	29 Mar	—21	31	30	1771137	11	40	0	1771127	5	7	1	12
9	4850	A	Tuesday	18 Mar	9	30	30	1771502	27	11	15	1771481	6	8	1	12
1750	1		Monday	6 April	23	30	31	1771867	42	42	30	1771865	7	9	2	13

Second Chronological Table, continued.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.				X.	XI.	XII.	
Christian years.	Years expired of the Cali yug	Character of the year.	Last feria in the Luni-solar year.	Date of the last mean conjunction in do.	Date in Chitra of Solar year.	Sydereal duration of Chitra.	Civil duration of Chitra.	Solar Ahargana, or Yugadin, to be counted from Friday.				Luni-solar Ahargana to be counted from Thursday.	Years of Æra Vicramaditya.	Fuzelee years expired.	Initial date, N. S.
					Syd.			DAYS.	G.	V.	P.	DAYS.			July
1751	4852		Saturday	27 Mar	—18	30	30	1772232	58	13	45	1772220	1808	1160	13
2	3	A	Wednes	15 Mar	— 7	31	30	1772598	13	45	0	1772574	9	1	12
3	4		Tuesday	3 April	25	30	30	1772963	29	16	15	1772958	1810	2	12
4	5	A	Saturday	23 Mar	15	30	31	1773328	44	47	30	1773312	1	3	13
5	6		Thursday	18 Mar	— 4	31	30	1773694	0	18	45	1773667	2	4	13
6	7		Tuesday	30 Mar	—22	31	30	1774059	15	50	0	1774050	3	5	12
7	8	A	Sunday	20 Mar	11	30	31	1774424	31	21	15	1774405	4	6	12
8	9		Saturday	8 April	30	30	31	1774789	46	52	30	1774789	5	7	13
9	4860		Wednes	28 Mar	—19	31	30	1775155	2	23	45	1775143	6	8	13
1760	1	A	Sunday	16 Mar	— 8	31	30	1775520	17	55	0	1775497	7	9	12
1	2		Saturday	4 April	26	30	31	1775885	33	26	15	1775881	8	1170	12
2	3		Thursday	25 Mar	16	30	31	1776250	48	57	30	1776236	9	1	13
3	4	A	Monday	14 Mar	— 5	31	30	1776616	4	28	45	1776590	1820	2	13
4	5		Sunday	1 April	—21	31	30	1776981	20	0	0	1776974	1	3	12
5	6	A	Thursday	21 Mar	12	30	31	1777346	35	31	15	1777328	2	4	13
6	7		Tuesday	11 Mar	— 2	30	30	1777711	51	2	30	1777683	3	5	13
7	8		Monday	30 Mar	—21	31	30	1778077	6	33	45	1778067	4	6	13
8	9	A	Friday	18 Mar	9	30	30	1778442	22	5	0	1778421	5	7	12
9	4870		Thursday	6 April	28	30	31	1778807	37	36	15	1778805	6	8	13
1770	1		Monday	26 Mar	—17	30	30	1779172	53	7	30	1779159	7	9	13
1	2	A	Saturday	16 Mar	— 7	31	30	1779538	8	38	45	1779514	8	1180	13
2	3		Friday	3 April	25	30	30	1779903	24	10	0	1779898	9	1	12
3	4	A	Tuesday	23 Mar	14	30	31	1780268	39	41	15	1780252	1830	2	13
4	5		Saturday	12 Mar	— 3	30	30	1780633	55	12	30	1780606	1	3	13
5	6		Friday	31 Mar	—22	31	30	1780999	10	43	45	1780990	2	4	13
6	7	A	Wednes	20 Mar	11	30	30	1781364	26	15	0	1781345	3	5	12
7	8		Monday	7 April	29	30	31	1781729	41	46	15	1781728	4	6	13
8	9		Saturday	28 Mar	—19	30	30	1782094	57	17	30	1782083	5	7	13
9	4880	A	Wednes	17 Mar	— 8	31	30	1782460	12	48	45	1782437	6	8	13
1780	1		Tuesday	4 April	26	30	30	1782825	28	20	0	1782821	7	9	12
1	2		Saturday	24 Mar	15	30	31	1783190	43	51	15	1783175	8	1190	13
2	3	A	Thursday	14 Mar	— 5	30	30	1783555	59	22	30	1783530	9	1	13
3	4		Wednes	2 April	—24	31	30	1783921	14	53	45	1783914	1840	2	13
4	5	A	Sunday	21 Mar	12	30	31	1784286	30	25	0	1784268	1	3	12
5	6		Thursday	10 Mar	1	30	31	1784651	45	56	15	1784622	2	4	13
6	7		Wednes	29 Mar	—20	31	30	1785017	1	27	30	1785006	3	5	13
7	8	A	Monday	19 Mar	—10	31	30	1785382	16	58	45	1785361	4	6	13
8	9		Sunday	6 April	28	30	31	1785747	32	30	0	1785745	5	7	12
9	4890		Thursday	26 Mar	17	30	31	1786112	48	1	15	1786099	6	8	13
1790	1	A	Monday	15 Mar	— 6	31	30	1786478	3	32	30	1786453	7	9	13
1	2		Sunday	3 April	—25	31	30	1786843	19	3	45	1786837	8	1200	13
2	3	A	Friday	23 Mar	14	30	31	1787208	34	35	0	1787192	9	1	13
3	4		Tuesday	12 Mar	3	30	31	1787573	50	6	15	1787546	1850	2	13
4	5		Monday	31 Mar	—22	31	30	1787939	5	37	30	1787930	1	3	13
5	6	A	Friday	20 Mar	10	30	30	1788304	21	8	45	1788284	2	4	13
6	7		Thursday	7 April	29	30	31	1788669	36	40	0	1788668	3	5	13
7	8		Tuesday	28 Mar	—19	30	30	1789034	52	11	15	1789023	4	6	13
8	9	A	Saturday	17 Mar	— 8	31	30	1789400	7	42	30	1789377	5	7	13
9	4900		Friday	5 April	26	30	30	1789765	23	13	45	1789761	6	8	13
1800	1		Tuesday	25 Mar	15	30	31	1790130	38	45	0	1790115	7	9	14

Second Chronological Table, continued.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.				X.	XI.	XII.	
Christian years.	Years expired of the Cali yug	Character of the year.	Last feria in the Luni-solar year.	Date of the last mean conjunction in da.	Date in Chitra of Solar year.	Sydereal duration of Chitra.	Civil duration of Chitra.	Solar Ahargana, or Yugadia, to be counted from Friday.				Luni-solar Ahargana to be counted from Thursday.	Years of Æra Vicramaditya.	Fuzelee years expired,	Initial date, N. S.
					Syd.			DAYS.	G.	V.	P.	DAYS.			July
1801	4902	A	Sunday	15 Mar	— 5	30	30	1790495	54	16	15	1790470	1858	1210	14
2	3		Friday	2 April	—23	31	30	1790861	9	47	30	1790853	9	1	14
3	4	A	Wednes	23 Mar	12	30	30	1791226	25	18	45	1791208	1860	2	14
4	5		Sunday	11 Mar	1	30	31	1791591	40	50	0	1791562	1	3	14
5	6		Saturday	30 Mar	—20	30	30	1791956	56	21	15	1791940	2	4	14
6	7	A	Wednes	19 Mar	— 9	31	30	1792322	11	52	30	1792300	3	5	14
7	8		Tuesday	7 April	27	30	30	1792687	27	23	45	1792684	4	6	14
8	9		Sunday	27 Mar	17	30	31	1793052	42	55	0	1793039	5	7	14
9	4910	A	Thursday	16 Mar	— 6	30	30	1793417	58	26	15	1793393	6	8	14
1810	1		Wednes	4 April	—25	31	30	1793783	13	57	30	1793777	7	9	14
1	2	A	Sunday	24 Mar	13	30	30	1794148	29	28	45	1794131	8	1220	14
2	3		Friday	13 Mar	8	30	31	1794513	45	0	0	1794486	9	1	14
3	4		Thursday	1 April	—22	31	30	1794879	0	31	15	1794870	1870	2	14
4	5	A	Monday	21 Mar	—11	31	30	1795244	16	2	30	1795224	1	3	14
5	6		Sunday	9 April	29	30	31	1795609	31	33	45	1795608	2	4	14
6	7		Thursday	28 Mar	18	30	31	1795974	47	5	0	1795962	3	5	14
7	8	A	Tuesday	18 Mar	— 8	31	30	1796340	2	36	15	1796317	4	6	14
8	9		Sunday	5 April	—26	31	30	1796705	18	7	30	1796700	5	7	14
9	4920	A	Friday	26 Mar	15	30	31	1797070	33	38	45	1797055	6	8	15
1820	1		Tuesday	14 Mar	4	30	31	1797435	49	10	0	1797409	7	9	14
1	2	(*)	Monday	2 April	—23	31	30	1797801	4	41	15	1797793	8	1230	14
2	3	AC	Saturday	23 Mar	—13	31	30	1798166	20	12	30	1798148	9	1	14
3	4		Wednes	12 Mar	1	30	31	1798531	35	43	45	1798502	1880	2	15
4	5		Tuesday	30 Mar	20	30	31	1798896	51	15	0	1798886	1	3	14
5	6	A	Saturday	19 Mar	— 9	31	30	1799262	6	46	15	1799240	2	4	14
6	7		Friday	7 April	27	30	30	1799627	22	17	30	1799624	3	5	14
7	8		Tuesday	27 Mar	16	30	31	1799992	37	48	45	1799978	4	6	15
8	9	A	Sunday	16 Mar	6	30	30	1800357	53	20	0	1800333	5	7	14
9	4930		Saturday	4 April	—25	31	30	1800723	8	51	15	1800717	6	8	14
1830	1	A	Wednes	24 Mar	13	30	30	1801088	24	22	30	1801071	7	9	14
1	2		Sunday	13 Mar	2	30	31	1801453	39	53	45	1801425	8	1240	15
2	3		Saturday	31 Mar	21	30	30	1801818	55	25	0	1801809	9	1	14
3	4	A	Thursday	21 Mar	—11	31	30	1802184	10	56	15	1802164	1890	2	14
4	5		Wednes	9 April	29	30	30	1802549	26	27	30	1802548	1	3	14
5	6		Sunday	29 Mar	18	30	31	1802914	41	58	45	1802902	2	4	15
6	7	A	Thursday	17 Mar	— 7	30	30	1803279	57	30	0	1803256	3	5	14
7	8		Wednes	5 April	—26	31	30	1803645	13	1	15	1803640	4	6	14
3	9	A	Monday	26 Mar	15	30	30	1804010	28	32	30	1803995	5	7	14
9	4940		Friday	15 Mar	4	30	31	1804375	44	3	45	1804349	6	8	15
1840	1		Thursday	2 April	—23	30	30	1804740	59	35	0	1804733	7	9	14
1	2	A	Monday	22 Mar	—12	31	30	1805106	15	6	15	1805087	8	1250	14
2	3		Saturday	12 Mar	1	30	51	1805471	30	37	30	1805442	9	1	14
3	4		Thursday	30 Mar	19	30	31	1805836	46	8	45	1805825	1900	2	15
4	5	A	Tuesday	19 Mar	— 9	31	30	1806202	1	40	0	1806180	1	3	14
4	6		Monday	7 April	—28	31	30	1806567	17	11	15	1806564	2	4	14
0	7		Friday	27 Mar	16	30	31	1806932	32	42	30	1806918	3	5	14
7	8	A	Tuesday	16 Mar	5	30	31	1807297	48	13	45	1807272	4	6	15
8	9		Monday	3 April	—24	31	30	1807663	3	45	0	1807656	5	7	14
9	4950		Saturday	24 Mar	—14	31	30	1808028	19	16	15	1808011	6	8	14
1850	1	A	Wednes	13 Mar	2	30	31	1808393	34	47	30	1808365	7	9	15

(*) The month which is expunged is Agrahayana or Margasiras. Those which are repeated are Aswina, and Chaitra the first of the ensuing year.

Second Chronological Table, continued.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.				X.	XI.	XII.	
Christian years.	Years expired of the Cali yug.	Character of the year.	Last feria in the Luni-solar year.	Date of the last mean conjunction in do.	Date in Chitra of Solar year.	Sydereal duration of Chitra.	Civil duration of Chitra.	Solar Ahargana, or Yogadin, to be counted from Friday.				Luni-solar Ahargana to be counted from Thursday.	Years of Æra Vicramaditya.	Fuzelee years expired.	Initial date, N. S.
					Syd.			DAYS.	G.	V.	P.	DAYS.			July
1851	4952		Tuesday	1 April	21	30	31	1808758	50	18	45	1808749	1908	1260	15
2	3	A	Saturday	20 Mar	—10	31	30	1809124	5	50	0	1809108	9	1	14
3	4		Friday	8 April	28	30	30	1809489	21	21	15	1809487	1910	2	14
4	5		Wednes	29 Mar	18	30	31	1809854	36	52	30	1809842	1	3	15
5	6	A	Sunday	18 Mar	— 7	30	30	1810219	52	23	45	1810196	* 2	4	15
6	7		Saturday	5 April	—26	31	30	1810585	7	55	0	1810580	3	5	14
7	8	A	Wednes	25 Mar	14	30	30	1810950	23	26	15	1810931	4	6	14
8	9		Monday	15 Mar	4	30	31	1811315	38	57	30	1811289	5	7	15
9	4960		Sunday	3 April	—23	30	30	1811680	54	28	45	1811673	6	8	15
1860	1	A	Thursday	22 Mar	—12	31	30	1812046	10	0	0	1812027	7	9	14
1	2		Wednes	10 April	30	30	30	1812411	25	31	15	1812411	8	1270	14
2	3		Sunday	30 Mar	19	30	31	1812776	41	2	30	1812765	9	1	15
3	4	A	Friday	20 Mar	— 9	30	30	1813141	56	33	45	1813120	1920	2	15
4	5		Wednes	6 April	—27	31	30	1813507	12	5	0	181350[illegible]	1	3	14
5	6		Monday	27 Mar	16	30	30	1813872	27	36	15	1813855	2	4	14
6	7	A	Friday	16 Mar	5	30	31	1814237	43	7	30	1814212	3	5	15
7	8		Thursday	4 April	—24	30	30	1814602	58	38	45	1814596	4	6	15
8	9	A	Monday	23 Mar	—13	31	30	1814968	14	10	0	1814950	5	7	14
9	4970		Saturday	13 Mar	2	30	30	1815333	29	41	15	1815305	6	8	14
1870	1		Friday	1 April	21	30	31	1815698	45	12	30	1815689	7	9	15
1	2	A	Tuesday	21 Mar	—10	31	30	1816064	0	43	45	1816045	8	1280	15
2	3		Monday	8 April	—29	31	30	1816429	16	15	0	1816427	9	1	14
3	4		Friday	28 Mar	17	30	31	1816794	31	46	15	1816781	1930	2	14
4	5	A	Wednes	18 Mar	7	30	31	1817159	47	17	30	1817136	1	3	15
5	6		Tuesday	6 April	—26	31	30	1817525	2	48	45	1817520	2	4	15
6	7	A	Saturday	25 Mar	—15	31	30	1817890	18	20	0	1817874	3	5	14
7	8		Wednes	14 Mar	3	30	31	1818255	33	51	15	1818228	4	6	15
8	9		Tuesday	2 April	22	30	31	1818620	49	22	30	1818612	5	7	15
9	4980	A	Sunday	23 Mar	—12	31	30	1818986	4	53	45	1818967	6	8	15
1880	1		Saturday	10 April	30	30	30	1819351	20	25	0	1819331	7	9	14
1	2		Wednes	30 Mar	19	30	31	1819716	35	56	15	1819705	8	1290	15
2	3	A	Sunday	19 Mar	— 8	30	30	1820081	51	27	30	1820069	9	1	15
3	4		Saturday	7 April	—27	31	30	1820447	6	58	45	1820443	1940	2	15
4	5	A	Thursday	27 Mar	16	30	30	1820812	22	30	0	1820798	1	3	14
5	6		Monday	16 Mar	5	30	31	1821177	38	1	15	1821152	2	4	15
6	7		Sunday	4 April	—24	30	30	1821542	53	22	30	1821536	3	5	15
7	8	A	Thursday	24 Mar	—13	31	30	1821908	9	3	45	1821890	4	6	15
8	9		Tuesday	13 Mar	2	30	30	1822273	24	35	0	1822245	5	7	14
9	4990		Sunday	31 Mar	20	30	31	1822638	40	16	15	1822628	6	8	15
1890	1	A	Friday	21 Mar	—10	30	30	1823003	55	37	30	1822983	7	9	15
1	2		Thursday	9 April	—29	31	30	1823369	11	8	45	1823367	8	1300	15
2	3		Monday	28 Mar	17	30	30	1823734	26	40	0	1823721	9	1	14
3	4	A	Saturday	17 Mar	6	30	31	1824099	42	11	15	1824075	1950	2	15
4	5		Thursday	5 April	—25	30	30	1824464	57	42	30	1824459	1	3	15
5	6	A	Tuesday	26 Mar	—15	31	30	1824830	13	13	45	1824814	2	4	15
6	7		Saturday	14 Mar	3	30	30	1825195	28	45	0	1825168	3	5	14
7	8		Friday	2 April	22	30	31	1825560	44	16	15	1825552	4	6	15
8	9	A	Tuesday	22 Mar	—11	30	30	1825925	59	37	30	1825906	5	7	15
9	5000		Monday	10 April	—30	31	30	1826291	15	18	45	1826290	6	8	15
1900	1		Saturday	31 Mar	19	30	31	1826656	30	50	0	1826645	7	9	15

NOTE

On the XIIth Column of the Second Chronological Table.

In the account which I have given of the Second Chronological Table, at page x of the Introduction, I was under the necessity of postponing what I had to say on the Carnatic *Fuzelee*, or Revenue year, for want of sufficient information on the subject. The cause of my hesitation arose principally from observing a difference of three years between the Bengal and Carnatic mode of reckoning in Revenue affairs, which (considering that the Fuzelee Æra was introduced in both countries by the Mahommedan government) appeared to me to originate rather with some error in the sources of my information, than from a deliberate intention on the part of those who originally instituted it in the Mogul Empire.

After some research into the subject, I regret, however, to state that the results went only to establish the fact, without explaining the occasion of the difference. The reader must therefore remain satisfied with the following imperfect account of the Revenue periods observed in this part of India.

The Carnatic Fuzelee year is a Solar one, and its construction is exactly the same as that of the Tamul *Saura Mana*, being of $365^d\ 15^g\ 31^v\ 15^p$, with this only difference, that instead of beginning with the 1st of the Solar month *Chaitram* (B. Vaisacha) it was ordained by the Mahommedan government, to commence on the 1st of Audi (B. Sravana), and as it only applies to Revenue affairs, the *Civil* year alone is considered in accounts.

Thus the Fuzelee year which begins on the 1st Audi of the 4927th of the Cali yug (1748th Saca) answering to the 1235th of that Æra, when referred to the European Kalendar, is found to commence on the 14th July 1825.

But we have seen at page ix of the Introduction that the Bengal corresponding Revenue year was the 1232d, and that it began with the *Moon's Wane* in the month of *Ashar* (Tamul *Auni*) (*). Hence the difference between the two accounts, amounts to two years, eleven months and some days; which difference may possibly proceed from some unknown cause, similar to that which has occasioned the discrepancy between the manner of counting the years of Jupiter (Vrihaspati Chacra) in Bengal, and in the Peninsula.

(*) How the Bengal Fuzelee year, being a *Solar* one, can be made to begin, in succession, with any of the Moon's change taken at pleasure in twelve consecutive Lunar Synodical months, was not explained to me. If there was any mistake in the statement referred to, it can only be rectified in Bengal.

But an innovation has occurred in the Carnatic, which (speaking as a Chronologer) I feel bound to predict, will create more confusion in the accounts of *remote* times, than the difference already adverted to. The Government of Fort St. George, taking probably the average Epoch of the beginning of the Mahommedan Fuzelee year (the same as that of the Tamul month Audi) for a great number of years and finding it to correspond with the 12th July, has directed its servants (with a view to greater regularity in revenue accounts) to fix in future the commencement of the Fuzelee year, on the above European date; so that agreeably to this arrangement, the *Revenue* is precisely equal to the European Civil year.

However, on casting a glance over the XIIth column under consideration, it will be immediately perceived that from A. D. 1600 to 1900 there is a difference of no less than *five days*, between the true and assumed beginning of the Fuzelee year, which will go on increasing at the rate of about two days in 120 Gregorian years, without there existing any periodical cause that might restore hereafter the supposed coincidence. A new Æra, which can be neither *Indian*, *Mahommedan*, nor *Christian*, will, therefore, be insensibly introduced, to perplex future Chronologers, who (excepting perhaps those who may chance to reside then under the Presidency of Fort St. George) will be unable to trace the institution to its true origin.

I am well informed that the inhabitants of these parts of India, although they do not object to the change ordered by Government when transacting with the Collectors, yet among themselves continue to abide by their old Fuzelee Kalendar; I conclude therefore, that when a change was found decidedly advisable, it would have been preferable to have adopted at once the 1st of January, instead of the 13th of July of the European year, because it would have prevented ambiguity; for call the present *official* Revenue year by any name that you please, it can never be any thing else, but an *European* account of time, disguised under a foreign name.

On the manner in which the Fuzelee years are registered in the XIIth column, I have only to repeat what I have said on the other accounts of time exhibited in these Tables; that is to say, that the numeral of the year, registered on a line with any Christian year inserted in the Ist column on the left, indicates that which expires on the day and month inserted in the second division of the XIIth column; observing that from A. D. 1600 to 1750 the beginning of the Fuzelee years is given both in *Old* and *New* Styles; and from 1750 to 1900 in *New* Style only.

Thus the Revenue year which ends on the 1st July O. S., and 12th July N. S. of the Christian year 1701, is the 1110th, and from that date to the end of the European year it is the 1111th.

And that which ends on the 14th July N. S. of the Christian year 1825 is the 1234th, and that which begins on the said date is the 1235th.

N. B.—As the Fuzelee year is never used but for revenue purposes, the Natives only mind its beginning, but never care for its subdivisions into months, days, &c.

⁂

III.

GENERAL CHRONOLOGICAL TABLE *exhibiting the years of the Hejira from Anno* 1 *to* 1318, *concurrent with the Christian years from A. D.* 622 *to* 1900, *and the date on which every Mahommedan year begins according to the European Kalendars of the Julian and Gregorian Styles.*

HEJIRA, according to Vulgar account - 16th July A. D. 622.
according to most ARABIAN ASTRONOMERS 15th July do.

From Anno Hejiræ 1 to 81.
From Anno Domini 622 to 700, Julian Style.

VIIth CENTURY.

From Anno Cali yugam 3723 to 3801.
From Anno 544 to 622 Saca.

Sunday 1. Etwar.			Monday 2. Peer.			Tuesday 3. Maugul.			Wedn. 4. Char Shumbol.			Thur. 5. Jummah Rhaut.			Friday 6. Jummah.			Satur. 7. Avul Haftah.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
3	624	24June	5 B	626	2June	2 B	623	5July	7 B	628	11 May	4	625	13June	1	622	16 July	6	627	23 May
11	632	29 Mar	8	629	1 May	10 B	631	9 Apr	15	636	14 Feb	12	633	18 Mar	9	630	20 Apr	14	635	25 Feb
16 B	637	2 Feb	13 B	634	7 Mar	18 B	639	12 Jan	23	643	19 Nov	19.1 20.5	640	2 Jan 21 Dec	17	638	23 Jan	22	642	30 Nov
19.1 20.5	640	2 Jan 21 Dec	21 B	641	10 Dec	26 B	646	17 Oct	31	651	24 Aug	28	648	25 Sep	25	645	28 Oct	*30	650	4 Sep
24 B	644	7 Nov	29 B	649	14 Sep	34	654	22 July	39	659	29 May	36	656	30June	33	653	2 Aug	35 B	655	11 July
27	647	7 Oct	37 B	657	19June	42	662	26 Apr	47	667	3 Mar	44	664	4 Apr	41	661	7 May	38	658	9June
32 B	652	12 Aug	45	665	24 Mar	50	670	29 Jan	55	674	6 Dec	52.5 53.2	672	3 Jan 27 Dec	46 B	666	13 Mar	43 B	663	15 Apr
40 B	660	17 May	52.5 53.2	672	3 Jan 27 Dec	58	677	3 Nov	63	682	10 Sep	*60	679	13 Oct	49	669	9 Feb	51 B	671	18 Jan
48 B	668	20 Feb	61	680	1 Oct	66	685	8 Aug	71	690	15June	65 B	684	18 Aug	54 B	673	16 Dec	59 B	678	23 Oct
56 B	675	25 Nov	69	688	6 July	74	693	13 May	76 B	695	21 Apr	68	687	18 July	57	676	14 Nov	67 B	686	28 July
64	683	30 Aug	77	696	10 Apr				79	698	20 Mar	73 B	692	23 May	62 B	681	20 Sep	75	694	2 May
72	691	4June										81 B	700	26 Feb	70 B	689	25 June			
80	699	9 Mar													78 B	697	30 May			

N. B.—The Letter B annexed to any year of the Hejira indicates that it is an intercalary one. And the Asterisk * and stroke ═══ below, that it is the last of the Cycle of 30 years. The years Cali yug and Saca are those about to end.

This Table is the first referred to in the Memoir on the Lunar year of the Mahommedans; the IVth of the Kala Sankalita.

Third Chronological Table, continued.

VIIIth CENTURY.

From Anno Hejiræ 82 to 184.
From A. D. 701 to 800.

From Anno Cali yugam 3802 to 3901.
From Anno 623 to 722 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
88	706	12 Dec	85	704	14 Jan	82	701	15 Feb	84 B	703	24 Jan	89 B	707	1 Dec	86B.6 87.4	705	2 Jan 23 Dec	83	702	4 Feb
96	714	16 Sep	93	711	19 Oct	*90	708	20 Nov	86B6 87.4	705	2 Jan 23 Dec	97 B	715	5 Sep	94	712	7 Oct	91	709	9 Nov
104	722	21June	101	719	24 July	95 B	713	26 Sep	92 B	710	29 Oct	105	723	10June	102	720	12 July	99	717	14 Aug
112	730	26 Mar	106 B	724	29 May	98	716	25 Aug	100 B	718	3 Aug	113	731	15 Mar	110	728	16 Apr	107	725	19 May
119B.3 120.1	737	8 Jan 29 Dec	109	727	28 Apr	103 B	721	1 July	108 B	726	8 May	121	738	18 Dec	118	736	20 Jan	115	733	21 Feb
125 B	742	4 Nov	114 B	732	3 Mar	111 B	729	5 Apr	116 B	734	10 Feb	129	746	22 Sep	126	743	25 Oct	123	740	26 Nov
128	745	3 Oct	117	735	31 Jan	119B.3 120.1	737	8 Jan 29 Dec	124	741	15 Nov	137	754	27June	134	751	30 July	131	748	31 Aug
133 B	750	9 Aug	122 B	739	7 Dec	127 B	744	13 Oct	132	749	20 Aug	145	762	2 Apr	142	759	4 May	136 B	753	7 July
141 B	758	14 May	130 B	747	11 Sep	135	752	18 July	140	757	25 May	153.5 154.2	770	4 Jan 24 Dec	*150	767	6 Feb	139	756	5June
149 B	766	16 Feb	138 B	755	16June	143	760	22 Apr	148	765	27 Feb	155 B	771	13 Dec	158	774	11 Nov	144 B	761	11 Apr
157 B	773	21 Nov	146 B	763	2 Mar	151	768	26June	156	772	2 Dec	161	777	9 Oct	163 B	779	17 Sep	147	764	10 Mar
165	781	26 Aug	153.5 154.2	770	4 Jan 24 Dec	159	775	31 Oct	164	780	6 Sep	166 B	782	15 Aug	171 B	787	22June	152 B	769	14 Jan
173	789	31 May	162	778	28 Sep	167	783	5 Aug	172	788	11June	169	785	14 July	179 B	795	27 Mar	160 B	776	19 Oct
181	797	5 Mar	170	786	3 July	175	791	10 May	*180	796	16 Mar	174 B	790	20 May				168 B	784	24 July
			178	794	7 Apr	183	799	12 Feb				177	793	18 Apr				176 B	792	28 Apr
												182 B	798	22 Feb				184	800	1 Feb

From Anno Hejiræ 185 to 238.
From A. D. 801 to 900.

IXth CENTURY.

From Anno Cali yugam 3902 to 4001.
From Anno 723 to 822 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
189	804	8 Dec	186.2 187B.6	802	10 Jan 30 Dec	191	806	17 Nov	185 B	801	20 Jan	190 B	805	27 Nov	186.2 187B.6	802	10 Jan 30 Dec	192	807	6 Nov
197	812	12 Sep	194	809	15 Oct	196 B	811	23 Sept	188	803	20 Dec	198 B	813	1 Sept	195	810	4 Oct	200	815	11 Aug
205	820	17 July	202	817	20 July	199	814	22 Aug	193 B	808	25 Oct	206 B	821	6 June	203	818	9 July	208	823	16 May
213	828	22 Mar	*210	825	24 Apr	204 B	819	28 June	201 B	816	30 July	214	829	11 Mar	211	826	13 Apr	216	831	18 Feb
220B.3 221.1	835	5 Jan 26 Dec	215 B	830	28 Feb	207	822	27 May	209 B	824	4 May	222	836	14 Dec	219	834	16 Jan	224	838	23 Nov
226 B	840	31 Oct	218	833	27 Jan	212 B	827	2 Apr	217 B	832	7 Feb	230	844	18 Sept	227	841	21 Oct	232	846	28 Aug
229	844	30 Sept	223 B	837	3 Dec	220B.3 221.1	835	5 Jan 26 Dec	225	839	12 Nov	238	852	23 June	235	849	26 July	*240	854	2 June
234 B	848	5 Aug	231 B	845	7 Sept	228 B	842	10 Oct	233	847	17 Aug	246	860	28 Mar	243	857	30 Apr	245 B	859	8 Apr
237	851	5 July	239 B	853	12 June	236 B	850	15 July	241	855	22 May	254.5 255.2	868	1 Jan 20 Dec	251	865	2 Feb	248	862	7 Mar
242 B	856	10 May	247 B	861	17 Mar	244	858	19 Apr	249	863	24 Feb	262	875	6 Oct	259	872	7 Nov	253 B	867	11 Jan
250 B	864	13 Feb	254.5 255.2	868	1 Jan 20 Dec	252	866	22 Jan	257	870	29 Nov	*270	883	11 July	264 B	877	13 Sept	256 B	869	10 Dec
258 B	871	18 Nov	263	876	24 Sept	260	873	27 Oct	265	878	3 Sept	275 B	888	16 May	267	880	12 Aug	261 B	874	16 Oct
266 B	879	23 Aug	271	881	29 June	268	881	1 Aug	273	886	8 June	278	891	15 Apr	272 B	885	18 June	269 B	882	21 July
274	887	28 May	279	892	3 Apr	276	889	6 May	281	894	13 Mar	283 B	896	19 Feb	280 B	893	23 Mar	277 B	890	25 Apr
282	895	2 Mar	287.2 288B.6	900	7 Jan 26 Dec	284	897	8 Feb	286 B	899	17 Jan				287.2 288B.6	900	7 Jan 26 Dec	285	898	28 Jan

Third Chronological Table, continued.

Xth CENTURY.

*From Anno Hejiræ 289 to 391.
From A. D. 901 to 1000.

From Anno Cali yugam 4002 to 4101.
From Anno 823 to 922 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
290	902	5 Dec	295	907	12 Oct	292	904	13 Nov	289	901	16 Dec	291 B	903	24 Nov	296 B	908	30 Sept	293	905	2 Nov
298	910	9 Sept	303	915	17 July	*300	912	18 Aug	294 B	906	22 Oct	299 B	911	29 Aug	304	916	5 July	309	921	12 May
306	918	14 June	311	923	21 Apr	301	913	7 Aug	297	909	20 Sept	307 B	919	3 June	312	924	9 Apr	317	929	14 Feb
314	926	19 Mar	316 B	928	25 Feb	305 B	917	24 June	302 B	914	27 July	315	927	8 Mar	320	932	13 Jan	325	936	19 Nov
321 B.3 322.1	933	1 Jan 22 Dec	319	931	24 Jan	308	920	23 May	310 B	922	1 May	323	934	11 Dec	328	939	18 Oct	333	944	24 Aug
*330	941	26 Sept	324 B	935	30 Nov	313 B	925	29 Mar	318 B	930	3 Feb	331	942	15 Sept	336	947	23 July	341	952	29 May
335 B	946	2 Aug	327	938	29 Oct	321 B.3 322.1	932	1 Jan 22 Dec	326 B	937	8 Nov	339	950	20 June	344	955	27 Apr	346 B	957	4 Apr
338	949	1 July	332 B	943	4 Sept	329 B	940	6 Oct	334	945	13 Aug	347	958	25 Mar	352	963	30 Jan	349	960	3 Mar
343 B	954	7 May	340 B	951	9 June	337 B	948	11 July	342	953	18 May	354 B.7 355.5	965	7 Jan 28 Dec	*360	970	4 Nov	354 B.7 355.5	965	7 Jan 28 Dec
351 B	962	9 Feb	348 B	959	14 Mar	345	956	15 Apr	350	961	20 Feb	363	973	2 Oct	365 B	975	10 Sept	357	967	7 Dec
359 B	969	14 Nov	356 B	966	17 Dec	353	964	19 Jan	358	968	25 Nov	371	981	7 July	368	978	9 Aug	362 B	972	12 Oct
367 B	977	19 Aug	364	974	21 Sept	361	971	24 Oct	366	976	30 Aug	376 B	986	13 May	373 B	983	15 June	370 B	980	17 July
375	985	24 May	372	982	26 June	369	979	29 July	374	984	4 June	379	989	11 Apr	381 B	991	20 May	378 B	988	21 Apr
383	993	26 Feb	380	990	31 Mar	377	987	3 May	382	992	9 Mar	384 B	994	15 Feb	388.2 389.B6	998	3 Jan 23 Dec	386 B	996	25 Jan
391	1000	1 Dec	388.2 389 B.5	998	3 Jan 23 Dec	385	995	5 Feb	*390	999	13 Dec	387	997	14 Jan						

From Anno Hejiræ 392 to 494.
From A. D. 1001 to 1100.

XIth CENTURY.

From Anno Cali yugam 4102 to 4201.
From Anno 923 to 1022 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
399	1008	5 Sep	396	1005	8 Oct	393	1002	10 Nov	395 B	1004	18 Oct	392 B	1001	20 Nov	397 B	1006	27 Sep	394	1003	30 Oct
407	1016	10June	404	1013	13July	401	1010	15 Aug	398	1007	17 Sep	400 B	1009	25 Aug	405	1014	2 July	402	1011	4 Aug
415	1024	15 Mar	412	1021	17 Apr	406 B	1015	21June	403 B	1012	23 July	408 B	1017	30 May	413	1022	6 Apr	410	1019	9 May
423	1031	19 Dec	*420	1029	20 Jan	409	1018	20 May	411 B	1020	27 Apr	416 B	1025	4 Mar	421.6 422B.3	1030	9 Jan 29 Dec	418	1027	11 Feb
431	1039	23 Sep	425 B	1033	26 Nov	414 B	1023	26 Mar	419 B	1028	31 Jan	424	1032	7 Dec	429	1037	14 Oct	426	1034	16 Nov
436 B	1044	29 July	428	1036	25 Oct	417	1026	22 Feb	427 B	1035	5 Nov	432	1040	11 Sep	437	1045	19 July	434	1042	21 Aug
439	1047	28June	433 B	1041	31Aug	421. 6 422B. 3	1030	9 Jan 29 Dec	435	1043	10 Aug	440	1048	16June	445	1053	23 Apr	442	1050	26May
444 B	1052	3 May	441 B	1049	5June	430 B	1038	3 Oct	443	1051	15May	448	1056	21 Mar	453	1061	26 Jan	*450	1058	28 Feb
447	1055	2 Apr	449 B	1057	10 Mar	438 B	1046	8 July	451	1059	17 Feb	455B.7 456.5	1063	4 Jan 25 Dec	461	1068	31 Oct	455B.7 456.5	1063	4 Jan 25 Dec
452 B	1060	6 Feb	457 B	1064	13 Dec	446 B	1054	12 Apr	459	1066	22 Nov	464	1071	29 Sep	466 B	1073	6 Sep	458	1065	3 Dec
460 B	1067	11 Nov	465	1072	17 Sep	454	1062	15 Jan	467	1074	27 Aug	472	1079	4 July	469	1076	5 Aug	463 B	1070	9 Oct
468 B	1075	16 Aug	473	1080	22June	462	1069	20 Oct	475	1082	1June	*480	1087	8 Apr	474 B	1081	11June	471 B	1078	14July
																		479 B	1086	18 Apr
476 B	1083	21 May	481	1088	27 Mar	470	1077	25 July	483	1090	6 Mar	485 B	1092	12 Feb	477	1084	10 May	487 B	1094	21 Jan
484	1091	23 Feb	488.5 489.2	1095	11 Jan 31 Dec	478	1085	29 Apr	491	1097	9 Dec	488.5 489.2	1095	11 Jan 31 Dec	482 B	1089	16 Mar			
492	1098	28 Nov				486	1093	1 Feb				493 B	1099	[illegible]	490 B	1096	19 Dec			
						494	1100	6 Nov												

Third Chronological Table, continued.

XIIth CENTURY.

From Anno Hejiræ 495 to 597.
From A. D. 1101 to 1200.

From Anno Cali yugam 4202 to 4301.
From Anno 1023 to 1122 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
500	1106	2 Sep	497	1103	5 Oct	502	1108	11 Aug	496 B	1102	15 Oct	501 B	1107	22 Aug	498 B	1104	23 Sep	495	1101	26 Oct
508	1114	7June	505	1111	18 July	*510	1116	16May	499	1105	13 Sep	509 B	1115	27 May	506 B	1112	28June	503	1109	31 July
516	1122	12 Mar	513	1119	14 Apr	515 B	1121	22 Mar	504 B	1110	20July	517 B	1123	1 Mar	514	1120	2 Apr	511	1117	5 May
524	1129	15 Dec	521	1127	17 Jan	518	1124	19 Feb	507	1113	18June	525	1130	4 Dec	522.6 523B.3	1128	6 Jan 25 Dec	519	1125	7 Feb
532	1137	19 Sep	526 B	1131	23 Nov	522. 6 523B.3	1128	6 Jan 25 Dec	512 B	1118	24 Apr	533	1138	8 Sep	530	1135	11 Oct	527	1132	12 Nov
*540	1145	24June	529	1134	22 Oct	531 B	1136	29 Sep	520 B	1126	27 Jan	541	1146	13June	538	1143	16 July	535	1140	17 Aug
545 B	1150	30 Apr	534 B	1139	28 Aug	539 B	1144	4 July	528 B	1133	1 Nov	549	1154	18 Mar	546	1151	20 Apr	543	1148	22 May
548	1153	29 Mar	537	1142	27 July	547 B	1152	8 Apr	536 B	1141	6 Aug	557	1161	21 Dec	554	1159	23 Jan	551	1156	25 Feb
553 B	1158	2 Feb	542 B	1147	2June	555. 3 556B.7	1160	12 Jan 31 Dec	544	1149	11 May	565	1169	25 Sep	562	1166	28 Oct	555.3 556B.7	1160	12 Jan 31 Dec
561 B	1165	7 Nov	550 B	1155	7 Mar	563	1167	17 Oct	552	1157	13 Feb	573	1177	30June	*570	1174	2 Aug	559	1163	30 Nov
569 B	1173	12 Aug	558 B	1161	10 Dec	571	1175	22July	560	1164	18 Nov	581	1185	4 Apr	575 B	1179	8June	564 B	1168	5 Oct
577 B	1181	17May	566 B	1170	14 Sep	579	1183	26 Apr	568	1172	23 Aug	586 B	1190	8 Feb	578	1182	7 May	567	1171	4 Sep
585	1189	19 Feb	574	1178	19June	587	1191	29June	576	1180	28 May	589.5 590.2	1193	7 Jan 27 Dec	583 B	1187	13 Mar	572 B	1176	10 July
593	1196	24 Nov	582	1186	24 May	595	1197	3 Nov	584	1188	2 Mar	594 B	1197	13 Nov	591 B	1194	16 Dec	580 B	1184	14 Apr
			589. 5 590. 2	1193	7 Jan 27 Dec				592	1195	6 Dec	597	1200	12 Oct				588 B	1192	18 Jan
																		596 B	1199	23 Oct

From Anno Hejiræ 598 to 697.
From A. D. 1201 to 1300.

XIIIth CENTURY.

From Anno Cali yugam 4302 to 4401.
From Anno 1123 to 1222 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
601	1204	29 Aug	598	1201	1 Oct	603	1206	8 Aug	*600	1203	10 Sep	602 B	1205	18 Aug	599 B	1202	20 Sep	604	1207	28 July
609	1212	3 June	606	1209	6 July	611	1214	13 May	605 B	1208	16 July	610 B	1213	23 May	607 B	1210	25 June	612	1215	2 May
617	1220	8 Mar	614	1217	10 Apr	616 B	1219	19 Mar	608	1211	15 June	618 B	1221	25 Feb	615	1218	30 Mar	620	1223	4 Feb
625	1227	12 Dec	622	1225	13 Jan	619	1222	15 Feb	613 B	1216	20 Apr	626 B	1228	30 Nov	623. 6 624 B. 3	1226	2 Jan 22 Dec	628	1230	9 Nov
633	1235	16 Sep	*630	1232	18 Oct	623. 6 624 B. 3	1226	2 Jan 22 Dec	621 B	1224	24 Jan	634	1236	4 Sep	631	1233	7 Oct	636	1238	14 Aug
641	1243	21 June	635 B	1237	24 Aug	627	1229	20 Nov	629 B	1231	29 Oct	642	1244	9 June	639	1241	12 July	644	1246	19 May
646 B	1248	26 Apr	638	1240	23 July	632 B	1234	26 Sep	637 B	1239	3 Aug	650	1252	14 Mar	647.	1249	16 Apr	652	1254	21 Feb
649	1251	26 Mar	643 B	1245	29 May	640 B	1242	1 July	645	1247	8 May	658	1259	18 Dec	655	1257	19 Jan	*660	1261	26 Nov
654 B	1256	30 Jan	651 B	1253	3 Mar	648 B	1250	5 Apr	653	1255	10 Feb	666	1267	22 Sep	663	1264	24 Oct	665 B	1266	2 Oct
656 B. 3 657. 1	1258	8 Jan 29 Dec	659 B	1260	6 Dec	656 B. 3 657. 1	1258	8 Jan 29 Dec	661	1262	15 Nov	674	1275	27 June	671	1272	29 July	668	1269	31 Aug
662 B	1263	4 Nov	667 B	1268	10 Sep	664	1265	13 Oct	669	1270	20 Aug	682	1283	1 Apr	676 B	1277	4 June	673 B	1274	7 July
670 B	1271	9 Aug	675	1276	15 June	672	1273	18 July	677	1278	25 May	*690. 5 691. 2	1291	4 Jan 24 Dec	679	1280	3 May	681 B	1282	11 Apr
678 B	1279	14 May	683	1284	20 Mar	680	1281	22 Apr	685	1286	27 Feb	695 B	1295	10 Nov	684 B	1285	9 Mar	689 B	1290	14 Jan
686 B	1287	16 Feb	*690.5 691.2	1291	4 Jan 24 Dec	688	1289	25 Jan	693	1293	2 Dec	698	1298	9 Oct	687	1288	6 Feb	697 B	1297	19 Oct
694	1294	21 Nov	699	1299	28 Sep	696	1296	30 Oct							692 B 700 B	1292 1300	12 Dec 16 Sep			

Third Chronological Table, continued.

From Anno Hejiræ 701 to 803.
From A. D. 1301 to 1400.

XIVth CENTURY.

From Anno Cali yugam 4402 to 4501.
From Anno 1223 to 1322 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
702	1302	26 Aug	707	1307	3 July	704	1304	4 Aug	701	1301	6 Sept	703 B	1303	15 Aug	708 B	1308	21 June	705	1305	24 July
710	1310	31 May	715	1315	7 Apr	712	1312	9 May	706 B	1306	13 July	711 B	1311	20 May	716 B	1316	26 Mar	713	1313	28 Apr
718	1318	5 Mar	723.2 724.6	1323	10 Jan 30 Dec	*720	1320	12 Feb	709	1309	11 June	719 B	1319	22 Feb	723.2 724.6	1323	10 Jan 30 Dec	721	1321	31 Jan
726	1325	8 Dec	731	1330	15 Oct	725 B	1324	18 Dec	714 B	1314	17 Apr	727 B	1326	27 Nov	732	1331	4 Oct	729	1328	5 Nov
734	1333	12 Sept	736 B	1335	21 Aug	728	1327	17 Nov	717	1317	16 Mar	735	1334	1 Sept	740	1339	9 July	737	1336	10 Aug
742	1341	17 June	739	1338	20 July	733 B	1332	22 Sept	722 B	1322	20 Jan	743	1342	6 June	748	1351	13 Apr	745	1344	15 May
*750	1349	22 Mar	744 B	1343	25 May	741 B	1340	27 June	730 B	1329	25 Oct	751	1350	11 Mar	756	1355	16 Jan	753	1352	18 Feb
755 B	1354	26 Jan	747	1346	24 Apr	749 B	1348	1 Apr	738 B	1337	30 July	759	1357	14 Dec	764	1362	21 Oct	761	1359	23 Nov
757B.3 758.1	1356	5 Jan 25 Dec	752 B	1351	28 Feb	757B.3 758.1	1356	5 Jan 25 Dec	746 B	1345	4 May	767	1365	18 Sept	772	1370	26 July	766 B	1364	28 Sept
763 B	1361	31 Oct	760 B	1358	3 Dec	765	1363	10 Oct	754	1353	6 Feb	775	1373	23 June	*780	1378	3 Apr	769	1367	18 Aug
771 B	1369	5 Aug	768 B	1366	7 Sept	773	1371	15 July	762	1360	11 Nov	783	1381	28 Mar	785 B	1383	6 Mar	774 B	1372	3 July
779 B	1377	10 May	776 B	1374	12 June	781	1379	19 Apr	770	1368	16 Aug	790B.7 791.5	1387	11 Jan 31 Dec	788	1386	2 Feb	777	1375	2 June
787 B	1385	12 Feb	784	1382	17 Mar	789	1387	22 Jan	778	1376	21 May	796 B	1393	6 Nov	793 B	1390	9 Dec	782 B	1380	7 Apr
795	1392	17 Nov	792	1389	20 Dec	797	1394	27 Oct	786	1334	24 Feb	799	1396	5 Oct	801 B	1398	13 Sept	790B.7 791.5	1387	11 Jan 31 Dec
803	1400	22 Aug	800	1397	24 Sep				794 802	1391 1399	29 Nov 3 Sep							798 B	1395	16 Oct

Third Chronological Table, continued.

From Anno Hejiræ 804 to 906.
From A. D. 1401 to 1500.

XVth CENTURY.

From Anno Cali yugam 4502 to 4601,
From Anno 1323 to 1422 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginhing A Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
811	1408	27 May	808	1405	29June	805	1402	1 Aug	*810	1407	8June	804 B	1401	11 Aug	809 B	1406	18June	806 B	1403	21 July
819	1416	1 Mar	816	1413	3 Apr	813	1410	6 May	815 B	1412	13 Apr	807	1404	10 July	817 B	1414	23 Mar	814	1411	25 Apr
827	1423	5 Dec	824.2 825.6	1421	6 Jan 26 Dec	821	1418	8 Feb	818	1415	13 Mar	812 B	1409	16 May	824. 2 825. 6	1421	6 Jan 26 Dec	822	1419	28 Jan
835	1431	9 Sep	832	1428	11 Oct	826 B	1422	15 Dec	823 B	1420	17 Jan	820 B	1417	18 Feb	833	1429	30 Sep	830	1426	2 Nov
843	1439	14June	*840	1436	16 July	829	1425	13 Nov	831 B	1427	22 Oct	828 B	1424	23 Nov	841	1437	5 July	838	1434	7 Aug
851	1447	19 Mar	845 B	1441	22 May	834 B	1430	19 Sep	839 B	1435	27 July	836 B	1432	28 Aug	849	1445	9 Apr	846	1442	12 May
856 B	1452	23 Jan	848	1444	10 Apr	837	1433	18 Aug	847 B	1443	1 May	844	1440	2June	857	1453	12 Jan	854	1450	14 Feb
858B 3 859.1	1454	1 Jan 22 Dec	853 B	1449	24 Feb	842 B	1438	24June	855	1451	3 Feb	852	1448	7 Mar	865	1460	17 Oct	862	1457	19 Nov
864 B	1459	28 Oct	861 B	1456	29 Nov	850 B	1446	29 Mar	863	1458	8 Nov	860	1455	11 Dec	873	1468	22 July	*870	1465	24 Aug
867	1462	26 Sept	869 B	1464	3 Sep	858B.3 859.1	1454	1 Jan 22 Dec	871	1466	13 Aug	868	1463	15 Sep	881	1476	26 Apr	875 B	1470	30June
872 B	1467	2 Aug	877 B	1472	8June	866 B	1461	6 Oct	879	1474	18 May	876	1471	20June	886 B	1481	2 Mar	878	1473	29 May
880 B	1475	7 May	885	1480	13 Mar	874	1469	11 July	887	1482	20 Feb	884	1479	25 May	889	1484	30 Jan	883 B	1478	4 Apr
888 B	1483	9 Feb	893	1487	17 Dec	882	1477	15 Apr	895	1489	25 Nov	891B.7 892.5	1486	7 Jan 28 Dec	894 B	1488	5 Dec	891B.7 892. 5	1486	7 Jan 28 Dec
896 B	1490	14 Nov	901	1495	21 Sep	890	1485	18 Jan	903	1497	30 Aug	*900	1494	2 Oct	897	1491	4 Nov	899 B	1493	12 Oct
904	1498	19 May				898 906	1492 1500	23 Oct 23 July				905 B	1499	8 Aug	902 B	1496	9 Sep			

From Anno Hejiræ 907 to 1009.
From Anno Domini 1501 to 1600.

XVIth CENTURY.

From Anno Cali yugam 4602 to 4701.
From Anno 1423 to 1522 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ	Anno Hejiræ	A. D.	Beginning A. Hejiræ
912	1506	24 May	909	1503	26June	914	1508	2 May	911	1505	4June	908	1502	7 July	910 B	1504	14June	907 B	1501	17 July
920	1514	26 Feb	917	1511	31 Mar	922	1516	5 Feb	916 B	1510	10 Apr	913 B	1507	13 May	918 B	1512	19 Mar	915	1509	21 Apr
928	1521	1 Dec	925.2 926B.6	1519	3 Jan 23 Dec	*930	1523	10 Nov	919	1513	9 Mar	921 B	1515	15 Feb	925. 2 926B. 6	1519	3 Jan 23 Dec	923	1517	24 Jan
936	1529	5 Sep	933	1526	8 Oct	935 B	1528	15 Sep	924 B	1518	13 Jan	929 B	1522	20 Nov	934	1527	27 Sept	931	1524	29 Oct
944	1537	10June	941	1534	13 July	938	1631	15 Aug	927	1520	12 Dec	937 B	1530	25 Aug	942	1535	2 July	939	1532	3 Aug
952	1545	15 Mar	946 B	1539	19 May	943 B	1536	20June	932 B	1525	18 Oct	945	1538	30 May	950	1543	6 Apr	947	1540	8 May
*960	1552	18 Dec	949	1542	17 Apr	951 B	1544	25 Mar	940 B	1533	2 July	953	1546	4 Mar	958. 6 959B. 3	1551	9 Jan 29 Dec	955	1548	11 Feb
965 B	1557	24 Oct	954 B	1547	21 Feb	958.6 959B.3	1551	9 Jan 29 Dec	948 B	1541	27 Apr	961	1553	17 Dec	966	1558	14 Oct	963	1555	16 Nov
968	1560	22 Sep	957	1550	20June	967 B	1559	3 Oct	956 B	1549	30June	969	1561	11 Sept	974	1566	19 July	971	1563	21 Aug
973 B	1565	29 July	962 B	1554	26 Nov	975	1567	8 July	964	1556	4 Nov	977	1569	16June	982	1574	23 Apr	976 B	1568	26June
981 B	1573	3 May	970 B	1562	31 Aug	983	1575	12 Apr	972	1564	9 Aug	985	1577	21 Mar	*990	1582	26 Jan	979	1571	26 May
989 B	1581	5 Feb	978 B	1570	5June				980	1572	14 May							984 B	1576	31 Mar
			986 B	1578	10 Mar				998	1580	17 Feb							987	1579	28 Feb
GREGORIAN REFORMATION 4TH OCTOBER 1582.																				
997 B	1588	10.20 Nov.	993. 5 994. 2	1585	24 Dec 1584 3 Jan 1585 12.23 Dec.	991	1583	15 25 Jan.	996	1587	22 Nov 2 Dec	993.5 994.2	1585	24 Dec 1584 3 Jan 1585 13.23 Dec.	995 B	1586	2.12D	992 B	1584	4.14 Ja
1005	1596	15.25 August †				999	1590	20 30 Oct.							998	1589	31 Oct 10 Nov	1000 B	1591	9.19 Oct,
			1002	1593	12.27 Sept.	1007	1598	25 July 4 Aug	1004	1595	27 Aug 6 Sep	1001	1592	28 Sep 8 Oct	1003 B	1594	6.16 Sept	1008 B	1599	14.24 July
												1006 B	1597	4.14 Aug.						
												1009	1600	3.13 Jul						

† The first number indicates the *Julian* and the second the *Gregorian* initial date.

XVIIth CENTURY.

From Anno Hejiræ 1010 to 1112.
From A. D. 1601 to 1700.

From Anno Cali yugam 4702 to 4801.
From Anno 1523 to 1622 Saca.

Sunday 1.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1013	1604	20 May	30 May
1021	1612	23 February	4 March
1029	1619	29 Nov.	8 Dec.
1037	1627	2 Sept.	12 Sept.
1045	1635	7 June	17 June
1053	1643	12 March	22 March
1060B3 1061.1	1650	25 Dec 1649 15 Dec.	4 Jan 1650 25 Dec.
1066.B	1655	21 October	31 October
1069	1658	19 Sept.	29 Sept.
1074B	1663	26 July	5 August
1077	1666	24 June	4 July
1082.B	1671	30 April	10 May
1090 B	1679	2 February	12 February
1098 B	1686	7 Nov.	17 Nov.
1106 B	1694	12 August	22 August

Monday 2.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1010	1601	22 June	2 July
1018	1609	27 March	6 April
1026.2 1027B6	1617	30 Dec. 1616 19 Dec. 1617	3 Jan. 29 Dec.
1034	1624	4 October	14 October
1042	1632	9 July	19 July
*1050	1640	13 April	23 April
1055B	1645	17 February	27 February
1058	1648	17 January	27 January
1063B	1652	22 Nov.	2 Dec.
1071B	1660	27 August	6 Sept.
1079B	1668	1 June	11 June
1087B	1676	6 March	16 March
1095	1683	10 Dec.	20 Dec.
1103	1691	14 Sept.	24 Sept.
1111	1699	19 June	29 June

Tuesday 3.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1015	1606	29 April	9 May
1023	1614	1 February	11 February
1031	1621	6 Nov.	16 Nov.
1036B	1626	12 Sept.	22 Sept.
1039	1629	11 August	21 August
1044B	1634	17 June	27 June
1047	1637	16 May	26 May
1052B	1642	22 March	1 April
1060B3 1061.1	1650	25 Dec 1649 15 Dec 1650	4 Jan 1650 25 Dec
1068B	1657	29 Sept.	9 October
1076B	1665	4 July	14 July
1084	1673	8 April	18 April
1092	1681	11 January	21 January
1100	1688	16 October	26 October
1108	1696	21 July	31 July

Wednesday 4.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1012	1603	1 June	11 June
*1020	1611	6 March	16 March
1025B	1616	10 January	20 January
1028	1618	9 Dec.	19 Dec.
1033B	1623	15 October	25 October
1041B	1631	20 July	30 July
1049B	1639	24 April	4 May
1057B	1647	27 January	9 February
1065	1654	1 Nov.	11 Nov.
1073	1662	6 August	16 August
1081	1670	11 May	21 May
1089	1678	13 February	23 February
1097	1685	18 Nov.	28 Nov.
1105	1693	23 August	2 Sept.

Third Chronological Table, continued.

XVIIth CENTURY, *continued.*

Thursday 5.				Friday 6.				Saturday 7.			
Anno Hejiræ	A. D.	Beginning A Hejiræ O. S.	Beginning A. Hejiræ N. S.	Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.	Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1014 B	1605	9 May	19 May	1011 B	1602	11 June	21 June	1016 B	1607	18 April	28 April
1017	1608	7 April	17 April	1019 B	1610	16 March	26 March	1024	1615	21 January	31 January
1022 B	1613	11 February	21 February	1026.2	1617	30 Dec 1616	9 January	1032	1622	26 October	5 Nov.
1030 B	1620	16 Nov.	26 Nov.	1027 B6		19 Dec 1617	29 Dec.	1040	1630	31 July	10 August
				1035	1625	23 Sept.	3 October				
1038 B	1628	21 August	31 August	1043	1633	28 June	8 July	1048	1638	5 May	15 May
1046 B	1636	26 May	5 June	1051	1641	2 April	12 April	1056	1646	7 February	17 February
1054	1644	28 February	10 March	1059	1649	5 January	15 January	1064	1653	12 Nov.	22 Nov.
1062	1651	4 Dec.	14 Dec.	1067	1656	10 October	20 October	1072	1661	17 August	27 August
1070	1659	8 Sept.	18 Sept.	1075	1664	15 July	25 July	*1080	1669	22 May	1 June
1078	1667	13 June	23 June	1083	1672	19 April	29 April	1085 B	1674	28 March	7 April
1086	1675	18 March	28 March	1091	1680	23 January.	2 February	1088	1677	24 February	6 March
1093 B7	1682	31 Dec 1681	10 January	1096 B	1684	28 Nov.	8 Dec.	1093 B7	1682	31 Dec 1681	10 January
1094.5		21 Dec 1682	31 Dec.					1094.5		21 Dec 1682	31 Dec.
1102	1690	27 Sept.	5 October	1099	1687	28 October	7 Nov.	1101 B	1689	5 October	15 October
*1110	1698	30 June	10 July	1104 B	1692	2 Sept.	12 Sept.	1109 B	1697	10 July	20 July
				1107	1695	2 August	12 August				
				1112 B	1700†	7 June	18 June				

† The new Style was introduced among the Protestant States of Germany in A. D. 1700, when 11 days were omitted in the month of February.

Third Chronological Table, continued.

From Anno Hejiræ 1113 to 1215.
From A. D. 1701 to 1800.

XVIIIth CENTURY.

From Anno Cali yugam 4802 to 4901.
From Anno 1623 to 1722 Saca.

Sunday 1.

Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1114	1702	17 May	28 May
1122	1710	19 February	2 March
1130	1717	24 Nov.	5 Dec.
1138	1725	29 August	9 Sept.
1146	1733	3 June	14 June
1154	1741	8 March	19 March
1161B3	1748	22 Dec 1747	2 Jan.
1162.1		11 Dec 1748	22 Dec.
*1170	1756	15 Sept.	26 Sept.
1175 B	1761	22 July	2 August
1178	1764	20 June	1 July
1183 B	1769	26 April	7 May
1191 B	1777	29 January	9 February
1199 B	1784	3 Nov.	14 Nov.
1207 B	1890	8 August	19 August
1215	1800	13 May	25 May

Monday 2.

Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1119	1707	24 March	4 April
1127 2	1715	27 Dec 1714	7 Jan.
1128B6		16 Dec 1715	27 Dec.
1135	1722	1 October	12 October
1143	1730	6 July	17 July
1151	1738	10 April	21 April
1156 B	1743	14 February	25 February
1159	1746	13 January	24 January
1164 B	1750	19 Nov.	30 Nov.
1167	1753	18 October	29 October
1172 B	1758	24 August	4 Sept.
1180 B	1766	29 May	9 June
1188 B	1774	3 March	14 March
1196 B	1781	6 Dec.	17 Dec.
1204	1789	10 Sept.	21 Sept.
1212	1797	15 January	26 January

Tuesday 3.

Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1116	1704	25 April	6 May
1124	1712	29 January	9 February
1132	1719	3 Nov.	14 Nov.
*1140	1727	8 August	19 August
1145 B	1732	13 June	24 June
1148	1735	13 May	24 May
1153 B	1740	18 March	29 March
1161B3	1748	22 Dec 1747	2 Jan.
1162.1		11 Dec 1748	22 Dec.
1169 B	1755	26 Sept.	7 October
1177 B	1763	1 July	12 July
1185	1771	5 April	16 April
1193	1779	8 June	19 June
1201	1786	13 October	24 October
1209	1794	18 July	29 July

Wednesday 4.

Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1113	1701	28 May	8 June
1121	1709	2 March	13 March
1126 B	1714	6 January	17 January
1129	1716	5 Dec.	16 Dec.
1134 B	1721	11 October	22 October
1137	1724	9 Sept.	20 Sept.
1142 B	1729	16 July	27 July
1150 B	1737	20 April	1 May
1158 B	1745	23 January	3 February
1166 B	1752†	28 October	8 Nov.
1174	1760	2 August	13 August
1182	1768	7 May	18 May
1190	1776	10 March	21 March
1198	1783	15 Nov.	26 Nov.
1206	1791	20 August	31 August
1214	1799	25 May	5 June

† The BRITISH REFORMATION of the Kalendar. In the year of Christ 1752 the Julian Kalendar was abolished by Act of Parliament (24th George II) and eleven days were expunged after the 2d of September of that year, by accounting the 3d to be the 14th day of the month. Public Officers in British India, when converting Indian, or Mahommedan dates, ascending before that Epoch, into European account, must therefore refer them to the Old Style, if they mean to have the date as then kept in England. However all the other Christian States of Europe (excepting Russia) followed the Gregorian Kalendar before that Epoch.

Third Chronological Table, continued.

XVIIIth CENTURY, *continued.*

Thursday 5.				Friday 6.				Saturday 7.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.	Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.	Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1115 B	1703	6 May	17 May	1120 B	1708	12 March	23 March	1117 B	1705	14 April	25 April
1118	1706	4 April	15 April	1127.2 1128B6	1715	27 Dec 1714 16 Dec 1715	7 Jan. 27 Dec.	1125	1713	17 January	28 January
1123 B	1711	8 February	19 February	1136 B	1723	20 Sept,	1 October	1133	1720	22 October	2 Nov.
1131 B	1718	13 Nov.	24 Nov.	1144	1731	25 June	6 July	1141	1728	27 July	7 August
1139 B	1726	18 August	29 August	1152	1739	30 March	10 April	1149	1736	1 May	12 May
1147 B	1734	23 May	3 June	1160	1747	2 January	13 January	1157	1744	4 February	15 February
1155	1742	25 February	8 March	1168	1754	7 October	18 October	1165	1751	9 Nov.	20 Nov.
1163	1749	30 Nov.	11 Dec.	1176	1762	12 July	23 July	1173	1759	14 August	25 August
1171	1757	4 Sept.	15 Sept.	1184	1770	16 April	27 April	1181	1767	19 May	30 May
1179	1765	9 June	20 June	1192	1778	19 January	30 January	1186 B	1772	24 March	4 April
1187	1773	14 March	25 March	*1200	1785	24 October	4 Nov.	1189	1775	21 February	4 March
1194B7 1195.5	1780	28 Dec 1779 17 Dec 1780	8 Jan. 28 Dec.	1205 B	1790	30 August	10 Sept.	1194B7 1195.5	1780	28 Dec 1779 17 Dec 1780	8 January 28 Dec.
1203	1788	21 Sept.	2 October	1208	1793	29 July	9 August	1197	1782	26 Nov.	7 Dec.
1211	1796	26 June	7 July	1213 B	1798	4 June	15 June	1202 B	1787	2 October	13 October
								1210 B	1795	7 July	18 July

Third Chronological Table, continued.

From Anno Hejiræ 1216 to 1318.
From A. D. 1801 to 1900.

XIXth CENTURY.

From Anno Cali yugam 4902 to 5001.
From Anno 1723 to 1822 Saca.

Sunday 1.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1223	1808	16 February	28 February
1231	1815	21 Nov.	3 Dec.
1239	1823	26 August	7 Sept.
1247	1831	31 May	12 June
1255	1839	5 March	17 March
1263	1846	8 Dec.	20 Dec.
1271	1854	12 Sept.	24 Sept.
1276 B	1859	19 July	31 July
1279	1862	17 June	29 June
1284 B	1867	23 April	5 May.
1287	1870	22 March	3 April
1292 B	1875	26 January	7 February
1300 B	1882	31 October	12 Nov.
1308 B	1890	5 August	17 August
1316 B	1898	10 May	22 May

Monday 2.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1200	1805	20 March	1 April
1228. 2	1813	23 Dec 1812	4 Jan.
1229B6		12 Dec 1813	24 Dec.
1236	1820	27 Sept.	9 October
1244	1828	2 July	14 July
1252	1836	6 April	18 April
*1260	1844	10 January	22 January
1265 B	1848	15 Nov.	27 Nov.
1268	1851	15 October	27 October
1273 B	1856	20 August	1 Sept.
1281 B	1864	25 May	6 June
1289 B	1872	28 February	11 March
1297 B	1879	3 Dec.	15 Dec.
1305	1887	7 Sept.	19 Sept.
1313	1895	12 June	24 June

Tuesday 3.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1217	1802	22 April	4 May
1225	1810	25 January	6 February
1233	1817	30 October	11 Nov.
1241	1825	4 August	16 August
1246 B	1830	10 June	22 June
1249	1833	9 May	21 May
1254 B	1838	15 March	27 March
1257	1841	11 February	23 February
1261.6	1845	29 Dec. 1844	10 Jan.
1262B3		18 Dec. 1845	30 Dec.
1270 B	1853	22 Sept.	4 October
1278 B	1861	27 June	9 July
1286 B	1869	1 April	13 April
1294	1877	4 January	16 January
1302	1884	9 October	21 October
1310	1892	14 July	26 July
1318	1900	18 April	1 May

Wednesday 4.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1222	1807	27 February	11 March
*1230	1814	2 Dec.	14 Dec.
1235 B	1819	8 October	20 October
1238	1822	6 Sept.	18 Sept.
1243 B	1827	13 July	25 July
1251 B	1835	17 April	29 April
1259 B	1843	20 January	1 February
1267 B	1850	25 October	6 Nov.
1275	1858	30 July	11 August
1283	1866	4 May	16 May
1291	1874	6 February	18 February
1290	1881	11 Nov.	23 Nov.
1307	1889	16 August	28 August
1315	1897	21 May	2 June

XIXth CENTURY, *continued.*

Thursday 5.				Friday 6.				Saturday 7.			
Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.	Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.	Anno Hejiræ	A. D.	Beginning A. Hejiræ O. S.	Beginning A. Hejiræ N. S.
1216 B	1801	2 May	14 May	1221 B	1806	9 March	21 March	1218 B	1803	11 April	23 April
1219	1804	31 March	12 April	1228. 2 1229 B.6	1813	23 Dec 1812 12 Dec 1813	4 Jan. 24 Dec.	1226 B	1811	14 January	26 January
1224 B	1809	4 February	16 February	1237 B	1821	16 Sept.	28 Sept.	1234	1818	19 October	31 October
1227	1812	4 January	16 January								
1232 B	1816	9 Nov.	21 Nov.	1245	1829	21 June	3 July	1242	1826	24 July	5 August
1240 B	1824	14 August	26 August	1253	1837	26 March	7 April	1250	1834	28 April	10 May
1248 B	1832	19 May	31 May	1261. 6 1262 B.3	1845	29 Dec 1844 18 Dec 1845	10 Jan. 30 Dec.	1258	1842	31 January	12 February
1256 B	1840	22 February	5 March	1269	1852	3 October	15 October	1266	1849	5 Nov.	17 Nov.
1264	1847	27 Nov.	9 Dec.	1277	1860	8 July	20 July	1274	1857	10 August	22 August
1272	1855	1 Sept.	13 Sept.	1285	1868	12 April	24 April	1282	1865	15 May	27 May
1280	1863	6 June	18 June	1293	1876	16 January	28 January	*1290	1873	17 February	1 March
1288	1871	11 March	23 March	1301	1883	21 October	2 Nov.	1295 B.7 1296.5	1878	24 Dec 1877 14 Dec 1878	5 January 26 Dec.
1295 B.7 1296.5	1878	24 Dec 1877 14 Dec 1878	5 Jan. 26 Dec.	1306 B	1888	26 August	7 Sept.	1298	1880	22 Nov.	4 Dec.
1304	1886	18 Sept.	30 Sept.	1309	1891	26 July	7 August	1303 B	1885	28 Sept.	10 October
1312	1894	23 June	5 July	1314 B	1896	31 May	12 June	1311 B	1893	3 July	15 July
				1317	1899	30 April	12 May				

END OF THE CHRONOLOGICAL TABLES.

I SHALL conclude this work by giving a short method for finding the initial root and feria (*Soota dina)* of any Tamul Solar year, past or to come, by means of the preceding Chronological Tables, and without reference to any other Rule whatsoever.

RULE.

I.

" If the proposed year is not to be found in any of the three centuries contained in the first " Chronological Table, raise or lower it by adding to, or subtracting from its numeral, as many " times 89 years, as will produce a year which is registered in the Table."

II.

" Take the root of the beginning of the year thus obtained, out of the XIth column of the " first Chronological Table, and subtract, or add inversely from what you did before, as many " times 1^{G} 21^{V} 15^{P}, as you have added or subtracted 89 years; and the sum or difference will " give the *Soota dina* required."

The accompanying small Table will considerably abridge the above process. It is to be entered with the figures which express the number of times, that you have added or subtracted 89 years from the numeral of the proposed one, in order to raise or lower it, to one which is to be found in the Chronological Table; and the column of Roots will furnish that which is applicable to the question.

The following examples will suffice for shewing the use of these Rules and Table, in all possible cases.

Number of Cycles.	Aggregate years in collective Cycles.	Roots.		
	Years.	G.	V.	P.
1	89	1	21	15
2	178	2	42	30
3	267	4	3	45
4	356	5	25	0
5	445	6	46	15
6	534	8	7	30
7	623	9	28	45
8	712	10	50	0
9	801	12	11	15
10	890	13	32	30
11	979	14	53	45
12	1068	16	15	0
13	1157	17	30	15

6/

EXAMPLE I.

Let us suppose that the years 1847, and 1764 of the Christian æra, are not to be found in the first Chronological Table, although the contrary be the case.

Dispose the numerals of these years separately, and see how many times it may be necessary to subtract or add 89 years to obtain one which is registered in the Chronological Table. Suppose that in both cases it is one; then proceed as follows:

	A. D. 1847	A. D. 1764
2d column small Table .	— 89	+ 89
Difference	1758	Sum 1853.

Now as we have used only one cycle of 89 years, the root to be used in both cases is (0^{d}) 1^{g} 21^{v} 15^{p} which is registered in the small Table opposite to 1 cycle, and 89 years.

Take out of the Chronological Table the initial roots which belong to the years 1758 and 1853 respectively, and proceed thus:

1758.	D.	G.	V.	P.	1853.	D.	G.	V.	P.
Page xxiv, - -	(0)	46	52	30	Page xxvi, -	(1)	21	21	15
Small Table, 3d col. +	(0)	1	21	15	—	(0)	1	21	15
Roots sought,	(0)	48	13	45		(1)	20	0	0

for a proof of which look in the same Chronological Table for the initial roots of the proposed years 1847, and 1764 at pages xxv and xxiv; and you find them to be the same as above, shewing that the Tamul Solar year of the Cali yug 4948 ends, and 4949 (each answering to the above Christian years) begins on a *Sunday*, Sydereal, and *Monday* Civil accounts; and that the year of the Cali yug 4865 ends and 4866 begins on a *Monday* Sydereal and Civil accounts.

EXAMPLE II.

Wanted the initial feria or *Soota dina*, of the years of the Cali yug which concur with A. D. 2311 and 683.

Proceeding as we did before, we find that *six* cycles of 89 years suffice for lowering the first of the two proposed years; and *thirteen*, to raise the last, to years to be found in the Chronological Table. Referring therefore to the small Table with the numbers 6 and 13, in the first column, the rule will be,

	A. D. 2311	A. D. 683
Small Table, 2d col. for 6 cycles, -	— 534	+ 1157
	1777	1840

both of which indicate years to be found in our Chronological Table; whose roots at pages xxiv and xxv will be found as follows:

A. D. 1777.	D.	G.	V.	P.	A. D. 1840.	D.	G.	V.	P.
Chronological Table, page xxiv, -	(3)	41	46	15	Page xxv, -	(5)	59	35	0
Small Table, 3d col. for 6 cycles, +	(0)	8	7	30	13 Cycles, —	(0)	17	36	15
Roots sought,	(3)	49	53	45		(5)	41	58	45

which shews that the Solar year 5413 of the Cali yug which answers to A. D. 2311 began on a *Wednesday* Sydereal, and *Thursday* Civil accounts; and that the year of the Cali yug 3785 which answers to A. D. 683 commenced on a *Friday* Sydereal, and *Saturday* Civil accounts.

The proofs of these results may easily be found by expounding the same *Soota dina* by means of the Tables XLVIII, page 63 and Example page 65 of the Astronomical Tables referred to in the *Kala Sankalita*.

THE END.

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The names of the following Gentlemen are here added, having been communicated too late for insertion in the general list. The Author takes this opportunity for stating, that to Mr. OLIVER and Mr. CAMPBELL's support, this work (in its present shape) owes chiefly its existence.

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A. D. Campbell, Esq. Judge of the Provincial Court of Chittoor.
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Kala Sankalita: A Collection of memories on the various modes according to which the nations of the southern parts of India divide time

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